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UNGULATE ASSESSENT IN THE COLUMBIA RIVER BASIN

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INTERIOR COLUMBIA BASIN
ECOSYSTEM MANAGEMENT PROJECT

UNGULATE ASSESSMENT IN THE COLUMBIA RIVER BASIN

This section is a brief statement summarizing the significance of the major ungulates of the Columbia River Basin. The seven species for which individual reports have been prepared are Elk, Mule deer, White-tailed deer, Bighorn sheep, Mountain goat, Pronghom, and Caribou. Other ungulates for which individual summaries have not been prepared include Moose, Black-tailed deer, Bison, and the California bighorn.

Collectively, these animals are distributed over virtually every square mile of the Columbia Basin. They represent a major social impact in both viewing opportunities and the influence of annual hunting seasons, they are extremely important economically, and their ecological impact, because they are all large herbivores influencing vegetation both directly and indirectly is felt throughout the basin.

The most important management issues vary among species, but usually they involve conflict with intensive human development and intensive agriculture. Federally managed public lands within the Columbia River Basin are thus extremely important in providing millions of'acres of suitable habitat for free-roaming ungulates.

Commodity extractions from public lands, such as mining and oil and gas leasing, have significant influences on wildland habitat. Natural resource management programs such as timber management and grazing can often be done in a manner that sustains habitat productivity, but human demands on public lands for recreational activities vary in compatibility. Faced with many different and sometimes conflicting demands, it is critical for land managers to identify and understand the primary issues and parameters that affect ungulates and their habitats in the CRB.

Authors for the summary material were:

Elk:

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Mule deer and White-tailed deer:

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Bighorn sheep:

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Mountain goat:

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Pronghorn (Antelope):

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Caribou:

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ISSUES	CORRELATES
ELK	
Road Access	Road Density/occurrence Open road density by season summer / fall range roadless areas
Vegetation Manipulation (Habitat Components)	Forested Acres Non-forested acres summer/fall range acres logged annually acres burned annually acres grazed (cattle allotments)
Grazing	Summer/fall range Cattle Allotments Primary Range
Security/refugia	Roadless areas Conifer Forest/patch Size Terrain Features Road densities Proximity to Human Development
Winter Range	Aspect Elevation Snow Depth Ownership patterns
Fire Management	Summer/fall Range Winter Range Wilderness fire plans fuel/fire models terrain features
Vulnerability	Summer/fall range Open road density State management Guidelines Forested Acres
Game Farms	Game Farm Locations

Models/guidelines	Cover/vegetation Roads/access State Guidelines Bull:cow ratios Hunter density/seasons
ORV's	Road Density Terrain Features Forested Acres summer/fall ranges Winter Range
Recreation	Road Density Trails/campsites Developed recreation sites Seasons of use by humans Summer/fall range Human densities
Tribal Relationships	Tribal ownership patterns Treating hunting rights boundaries Proximity of Public lands Summer/fall range Winter range Road Densities
Land Ownership	Ownership Patterns Private/corporate management summer/fall range winter range

ISSUES	CORRELATES
MULE DEER	
Forage	acres logged annually acres burned annually miles of road on winter range human population density
Snow depth	snow depth 20 inches
Competition with livestock	acres of sheep allotments acres of cattle allotments
Fire management	acres prescribed fire acres wild fire
Logging	acres logged
Urban development	Human population density road density
Road access	none suggested
Poaching	Road density Human population density
Domestic dogs Highways Vehicle mortality	none suggested

ISSUES	CORRELATES
WHITE-TAILED DEER	
Forage	Shrub fields riparian zone abandoned farm fields
Snow depth	snow depth 20 inches
Competition	Moose range Livestock allotments Elk winter range
Fire management	acres prescribed fire acres wild fire
Logging	acres logged, last 3-5 yrs
Urban development	Human population density Homes/cabin density adjacent to federal lands Recreation sites/mile of riparian Seasonal use at recreation sites road density
Farm practices	acres of specific croplands ratio of agricultural land to successional habitat
Road access	Road density
Poaching	Road density Human population density
Domestic dogs Highways Vehicle mortality	none suggested

ISSUES	CORRELATES
SHEEP	
Diseases	Domestic sheep allotments Livestock Allotments
Grazing	
Vegetation Manipulation	Seasonal Ranges Mixed shrub/grasslands Shrublands Potential habitat
Human Disturbance	Escape terrain Proximity to humans Seasonal Ranges
Vacant Habitat	Suitable habitat Domestic sheep allotments
Key Habitats	Winter range
Wilderness Management	Wilderness Management Amount of habitat Aircraft Access
Models	Topographic features Escape Terrain Human Activities Centers Bighorn population parameters

ISSUES	CORRELATES
MOUNTAIN GOAT	
Road Access	Road Density Proximity to escape terrain Winter open road density
Vegetation Management	Cover/forage ratios Road density Proximity to escape terrain
Security	Proximity to escape terrain Road Density
Winter Range	Juxtaposition to winter range Rock/cliff habitat
Fire Management	Let burn policy Prescribed bums
Harvest Management	(none identified)
Predator/Prey Relationships	
Competition (forage)	
Recreation	Subdivision/summer cabins Destination ski resorts

ISSUES	CORRELATES
PRONGHORN ANTELOPE	
Fencing	Livestock grazing allotments
Livestock grazing on rangeland shared with pronghorn	Livestock grazing allotments Spring range
Predation and food for carnivores	Coyote populations Golden eagle Bobcat Mountain lion
Improving degraded Rangeland	Sub-climax vegetation Shrub encroachment
Habitat Models	Grass/forbs in spring Subclimax vegetation
Habitat Parameters favoring pronghorn	-low rolling to flat terrain -20-38 cm precipitation -snow depths under 30cm -grass / forb rangelands, <45 cm -open water sources

ISSUES	CORRELATES
MOUNTAIN CARIBOU	
Late Successional Stands	Western Cedar/Hemlock Engelmann spruce/subalpine fir Ecotone habitat Acres of potential old-growth
Human Disturbance	Groomed Snowmobile trails Open Alpine assessable areas
Fire	Access management Acres of non-target stands
Herd Augmentation	Public Acceptance Animal availability
Direct Mortality	Predator control Access management Law enforcement Public education

1) PREAMBLE FOR UNGULATE ASSESSMENT: ELK IN THE CRB

Federally managed public lands within the Columbia River Basin provide millions of acres of suitable elk habitat, perhaps representing a third of occupied elk habitat in the United States. Annually, 350,000 to 450,000 hunters pursue elk within western Montana, Idaho, Oregon, and Washington. In addition, several million people come to observe wildlife, of which elk are a primary attraction. Elk represent major social and economic factors in the CRB, and because of the dispersed nature of elk distributions, virtually all areas within the CRB are affected.

Data collected for the 1991 USFWS survey on hunting fishing indicate that direct expenditures for elk hunting in this area total about $110.5 million annually. Teisl and Southwick (1995) have shown that the economic impact of elk hunting represents $225.3 million and 3,467 jobs. Many small communities and small businesses reap the economic benefits of elk. Elk license sales generally represent the largest single revenue source for state game departments within the CRB. Clearly the management of publicly owned elk habitat has ramifications that reach far beyond the boundaries of public lands.

In addition to high social and economic values, elk fulfill a number of ecological roles. As a large, mobile herbivore, elk undoubtedly influence vegetation either directly or indirectly. Their social behavior and survival strategies influence other ungulates that may occupy similar habitats. As a large prey species, elk contribute to the support of predators capable of killing them; namely mountain lions, bears, wolves, and perhaps coyotes. As carrion, the natural loss combined with hunting mortality and paunches left in the field represent a significant source of food for a host of avian and mammalian predators and scavengers, many of which are considered threatened or endangered.

Roughly 220,000 elk occupy about 33 million acres of habitat on National Forest lands within the CRB (need BLM data). Managers of these lands must respond to a myriad of demands by various elements of the public, many of which are in conflict with managing elk habitat. Commodity extractions from public lands, such as mining and oil and gas leasing, portend significant influences on elk habitat. Natural resource management programs such as timber management and grazing can often be done in a manner that sustains elk habitat. Human demands on public lands for recreational activities vary in compatibility. Faced with these many situations, it is critical for land managers to identify and understand the primary issues and parameters that will enable them to recognize and make decisions regarding elk and elk habitat. This document attempts to provide a focus on primary issues, suggest key habitat correlates, and lay a foundation for identifying and understanding elk habitat within the context of a landscape assessment of the Columbia River Basin.

2) DEFINITIONS

ISSUE is any consideration, usually created or controlled by man, that has 1) a direct influence on elk, or 2) on the distribution of elk, or 3) on the environmental correlates that influence the fitness of elk or elk herds.

Primary issues are those elements of elk and elk habitat management that can specifically define and control elk numbers or elk habitat over time. In virtually all cases, primary issues will emerge from the careful analysis of site-specific opportunities, problems or concerns. Primary issues constitute the basic, relevant parameters that can be used on a landscape basis to understand elk and elk habitat relationships. They are generally biological in nature and can be quantified, observed, and modelled.

Related issues are those that bring context and site specific resolution to elk and elk habitat situations. They are often social in nature and influence the primary biological elements either positively or negatively. Related issues are frequently the starting point in elk management considerations, but generally must be reduced to primary issues in order to identify implementable actions. There is a strong interactive relationship between primary and related issues.

CORRELATES are any factor that affects the distribution, abundance, and fitness of elk or elk herds. In the context of application to CRB, environmental correlates should be detectable as a surface feature on the GIS coverages available for CRB analysis.

Identifying correlates can sometimes be aided by asking, what niche does the species fill?, what evolutionary function does the species serve?, what characters of landscape make it suitable?, what are the species limits, terrain and weather?

3) LIST OF ISSUES

Primary:
Road access
Vegetation manipulation
Grazing / livestock
Security
Winter range
Fire Management
Elk vulnerability
Game farms
Models / management guidelines
Motorized vehicles

Related:
Recreation / recreation development
Tribal relationships
Subdivision / Development
Intermingled lands / private ownership

4) BRIEF, OBJECTIVE STATEMENT ABOUT EACH ISSUE

The purpose of this section is to clearly identify each issue and the associated correlates and to provide a few key literature citations. We attempt to be completely generic and describe the situation without being judgmental.

In most cases these are issues because they affect the species or species habitat, and because they are action items for the Forest Service and / or BLM. Each issue has a geographic context: it is important throughout the Columbia Basin, or it is more localized. If localized it is important everywhere, or it is more important some places than others.

Primary
ROADS / ACCESS

Forest roads are the primary mode of access into elk habitat and are an issue throughout the North American elk range. The literature of elk habitat management and elk vulnerability demonstrate that the presence of roads and the vehicle traffic on those roads have a continuing negative influence on elk. Elk summer and fall ranges are the focal point, but roads on winter range are also problematical. Independent of the hunting season, motorized use of forest roads produce a disturbance that prevents full utilization of the available habitat. The losses in potential use of habitat can exceed 50 percent when open road densities exceed 2 miles of road per section. The influence of open roads during the hunting season has not been as well documented, but all the reported research demonstrates the probabilityof bull elk survival in proximity to open roads is quite low. Roadkill on major highways is rarely an important cause of death for elk, but major interstate freeways may act as movement barriers in some cases.

Suggested Correlates:

- road density / occurrence
- open road density by season
- elk summer / fall range
- roadless areas

Selected References:

Christensen et al. (1993)
Hieb (1976)
Lyon (1983, 1984b)
Wisdom et al. (1986)

Primary

VEGETATION MANIPULATION / HABITAT MANIPULATION

Changes in the structure and composition of vegetation that provides elk habitat, whether intentional or an indirect result of other management actions, is a primary issue in elk management. Direct changes wrought by timber harvest, prescribed fire, or managed wildfires are common events across publicly owned forest lands. Less evident but of significant importance are the indirect effects of fire suppression, livestock grazing and the introduction of noxious weeds. Changes in vegetation will affect foraging opportunities, modify security, change thermal regimes, influence elk vulnerability, and can change the patterns of elk use over large areas over time. While elk are very adaptive and resilient, there are key vegetative components of their environment that are recognized and detailed in existing models. These components will strongly influence the presence and thrift of elk herds. These components, consisting basically of forested cover, openings with preferred foods, and seasonally important forage sites, must exist in sizes, patterns, and combinations across the landscape that meet the habitat criteria needed to support and sustain elk. The composition, juxtaposition, and scale of these vegetative patterns across the landscape are a direct result of management decisions regarding vegetative manipulation and are, therefore, of direct influence on elk.

Suggested Correlates:

- forested acres
- non-forested acre (within elk habitat)
- elk summer/fall range
- acres logged annually
- acres burned annually
- acres grazed (active cattle allotments)

Selected References:

Christensen et al. (1993)
Leege (1984)
Lyon (1984a)
Lyon et al. (1985)
Thomas et al. (1979)
Wisdom et al. (1986)

Primary
GRAZING/LIVESTOCK

Livestock grazing on public lands is currently one of the largest issues facing the West. Most public land agencies have been sensitized in recent years by the various plans to raise grazing fees and restructure grazing allotments. Grazing of domestic livestock on public forests and grasslands is a long accepted multiple use practice. Where elk and cows occur together on elk summer range, some research indicates the elk may be displaced or that cattle will occupy and dominate use of key wet sites. Competition for forage has been raised as an issue, predominantly during spring greenup. Cattle use on elk winter ranges, however, has been shown to enhance forage conditions for wintering elk. Complicating these relationships is the frequent occurrence of wintering elk on private lands of allotment permittees. Viable ranching operations can provide foraging opportunities for elk as well as security during hunting seasons and recreational opportunities such as viewing. In many instances, if ranching operations became non viable, the land would be sold and developed or subdivided with a resultant loss of open space, security, and foraging opportunity for elk. Problems between elk and other domestic livestock are generally site specific and minimal.

Suggested Correlates:

- elk summer/fall range
- active cattle allotments
- primary range

Selected References:
Anderson and Scherzinger (1975)
Irwin et al. (1994)
Lyon et al. (1985)
Mackie (1978)
Skovlin et al. (1968)

Primary
SECURITY

As a management concern, security can be defined as any combination of habitat conditions that will allow elk to remain in a defined area despite an increase in stress or disturbance associated with humans. Combinations of forest cover, low road densities, terrain features and proximity to human activities are defining criteria. Security is an essential management consideration for all seasons in elk habitats. Security is the antithesis of disturbance and is a necessary component of a landscape that will support viable elk herds over time.

Suggested Correlates:

- roadless areas
- conifer forest, patch size
- terrain features, slope, relief
- road densities
- proximity to human developments

Selected References:
Hillis et al. (1991)
Lyon and Canfield (1991)
Lyon and Christensen (1992)
Unsworth and Kuck (1991)

Primary
WINTER RANGE

Winter ranges are largely defined by landscape elements such as elevation, slope, aspect, and proximity to major valley bottoms. Forage availability and snow depth are site specific elements that reflect the influence of the many factors. Winter ranges are often of historical significance and reflect the limited options available to wintering elk that may summer on vast acreages miles distant from wintering sites. The management of winter ranges is critical to the long term welfare of elk populations.

Direct manipulation of winter range vegetation with prescribed fire is a common practice in the CRB. Generally, the rationale is to enhance on-site forage production to increase carrying capacity. Management of forested components of winter range is less well understood, but providing for thermal needs and snow intercept are the overriding considerations for elk.

Dramatic negative effects on winter ranges result from a number of human-induced changes. Development for housing, recreation, or agriculture, introduction of noxious weeds, and reductions in security related to the encroachment of human developments all eliminate or reduce winter range for elk. Carefully coordinated grazing of domestic livestock can be a compatible use on some elk winter ranges. Use by wintering elk of adjacent private lands is an important and controversial subject in the CRB.

Suggested Correlates:

- elk winter ranges
- elevation
- snow depth
- ownership patterns

Selected References:

Asherin (1968)
Beall (1968)
Edwards (1956)
Leege (1968)
Leege and Hickey (1977)
Riggs et al. (1990)
Thomas et al. (1986)

Primary
FIRE MANAGEMENT

The major focus in fire management dating from early in this century has been to suppress wildfires. Agencies have been very effective, and in the last 50 years the extent of wildfire across the West has been dramatically reduced. Fire is a major ecological process in the CRB and is largely responsible for shaping and defining the patterns of vegetation that exist today. Land managers are beginning to realize that exclusion of fire on a major scale has resulted in vegetation conditions that may not fit long term patterns and that provide opportunities for wildfires of a much more intense and destructive nature. We are faced with the prospect of fires that modify large acreages of vegetation in a radical way rather than fires that shaped and stimulated vegetative patterns across the landscape on a smaller scale.

Elk habitat and elk in the CRB respond in positive ways to fire. The use of prescribed fire for winter range improvement is a proven practice. Fires that burn in historical patterns across summer ranges create openings, stimulate forage, and perpetuate a mosaic of cover and forage across the landscape. In general, fire is a positive force in shaping elk habitat when it occurs in a low intensity, relatively frequent, form across the landscape. The challenge facing land managers today is how to return fire to a role more reminiscent of a century ago within the context of forests with much higher fuel loading and with a greatly expanded interface of private ownership and development. In reaching fire management decisions, elk habitat can be one of a number of beneficiaries as agencies move to a more liberal policy of managing rather than suppressing fire.

Suggested Correlates:

- summer/fall range
- winter range
- wilderness fire plans
- fuel models/fire models
- terrain features

Selected References:
Lozensky, Amo, Gruell
Asherin (1976)
Habeck (1987)
Irwin (1976)
Mutch (1994)

Primary
ELK VULNERABILITY

Vulnerability encompasses a complex relationship that includes elk habitat, elk behavior, human behavior, agency roles and activities and the nature of the landscape; all of which work together to define the probability of bull survival and herd vitality. The term vulnerability is most often used in relation to sport hunting and bull survival under hunting conditions, but normal activities of forest management, such as road construction and vegetation manipulation, have significant effects on elk vulnerability. Bull elk survival rates have significant biological and social values related to elk behavior and reproduction and to human recreation and esthetics.

Suggested Correlates:

- elk summer/fall range
- road density
- state management guidelines
- forested acres

Selected References:

Christensen et al. (1991)
Christensen et al. (1993)
Hillis et al. (1991)
Lyon and Canfield (1991)
Thomas (1991)
Vales (1995)
Vales et al. (1991)

Primary
'GAME FARMS

Game farms are privately owned business enterprises at which one or more wild ungulate species are raised as domestic livestock for marketable products. The products sold from such operations range from meat and antlers to guided trips for hunting and/or photography. Game farms are illegal in Oregon, but licensed and tolerated in the other Columbia Basin states.

A primary concern related to game farms is the harboring and fostering of diseases which have the potential to significantly affect wild elk populations. A related concern is that infected game farm elk will escape and be a disease vector among wild, free ranging elk. Tuberculosis, for example, is relatively common in game farms, and if established in wild populations would be impossible to control. Complicating these concerns is the general location of game farms which are often adjacent to public lands and in the vicinity of wild, free ranging elk. Finally, genetic contamination of wild elk by escaped game farm elk of questionable origin is another concern.

Suggested Correlates:

- locations of game farms near or adjacent to USFS lands

Selected References:

Geist (1991)
Lanka and Guenzel (1991)

Primary
MODELS/MANAGEMENT GUIDELINES

The design and testing of models that help managers understand the habitat characteristics that favor elk has been an important development in elk management. Most models date from the mid 1970s and focus on forest vegetation variables that can be manipulated. Even more recently, State management guidelines that identify and project elk population parameters by hunting district have been an important addition. These two kinds of models respectively reflect the roles of land mangers and population managers. Independently, they can only portray part of the considerations in elk management. Together they become synergistic and provide a powerful evaluation of elk management parameters.

Because the vast majority of elk in the CRB reside on public lands and their numbers are largely controlled through state regulated hunting, the management of elk and elk habitat demands that both land management and population models be used in concert.

Suggested Correlates:

- existing habitat models
- cover/vegetation parameters
- roads/density, access
- summer-fall range
- existing state guidelines
- bull:cow ratios
- hunter numbers and seasons

Strategic plans, Idaho and Montana

Primary
MOTORIZED VEHICLES

This element is strongly linked to developed road systems, but not completely. Recent technological developments in off road recreational vehicles have effectively opened many acres of elk habitat to disturbance on a virtually year around basis. This factor is strongly influenced by terrain features that favor ORV and snowmobile usage, that is gentle slopes, open or relatively open forests, and ridge complexes that are undulating and linked together. Motorized vehicles can be a significant disturbance factor on summer range, where elk habitat use is effectively reduced; they can increase elk vulnerability during the hunting season; and, on winter ranges, they can be a disturbance factor that is potentially fatal.

Suggested Correlates:

- Road density
- terrain features
- forested acres
- summer/fall ranges
- winter ranges

Selected References:
Geist (1978)
Henkel (1991)
Ward and Cupal (1979)

Related
RECREATION AND RECREATION DEVELOPMENT

Recreation activities are related to other issues in elk management because they introduce humans and human development into or upon elk habitat. In general, non-motorized dispersed forms of recreation have not been demonstrated to be of major significance to elk, but it has nevertheless been documented that any kind of human induced disturbance of free ranging wild animals is likely to be detrimental in some degree. In the context of elk vulnerability, trails and recreation access facilitate the harvest of elk and may be an important consideration at the local level.

As recreation trends to more development of sites and increased usage of motorized vehicles, there is a measurable decline in the effectiveness of habitat to support elk. At the extreme, placement of recreation sites and supporting development (for example, . paved roads, campgrounds) with attendant high density human use can cause a total loss of elk habitat. Existing habitat models can quantify this effect.

Another factor related to the human:elk interaction is the important concept of accommodation. Elk residing on National Forest lands cannot be compared behaviorally with elk residing in National Parks. As hunted elk, it is desirable that they retain avoidance responses to humans and human development. Therefore, in terms of recreation and recreation development, the presence of elk in and around recreation sites should not be considered desirable or reduce the consideration·given elk or their habitat. Developments which offer viewing opportunities for elk must do so in a manner that provides maximum opportunity for elk to retain wild elk behavior patterns.

Suggested Correlates:

- road density
- trails and campsites
- developed recreation sites
- seasons of use by humans
- summer-fall elk range
- elk winter range
- human densities at recreation sites/corridors

Selected References:

Field and Muth (1994)
Murphy et al. (1991)
Ream (1980)
Ward and Cupal (1979)

Related
TRIBAL RELATIONSHIPS

This related issue can generally be defined from two perspectives: 1) tribal ownership patterns, and 2) the exercising of treaty hunting rights. Lands owned by tribes provide substantial acreages of elk habitat in the CRB. Most tribes have implemented or are developing management programs to benefit from wildlife resources. Depending on the traditions and religious beliefs of the various tribes, wildlife may be managed exclusively for tribal members on tribal lands or there may be opportunity for non-members to view or hunt wildlife on tribal lands. This is a highly variable situation. Elk occurring on tribal lands frequently mingle with elk from adjacent National Forest lands and may be influenced by habitat and hunting management off tribal lands. Thus, the emergence of tribal wildlife management programs creates the possibility of cooperative management of elk.

The second consideration is much more complex and fraught with misunderstanding. Treaty rights ascribed to various tribes through a number of treaties dating from the late 1800s granted hunting right on vast areas of unclaimed public lands. The exercise of these rights on National Forests and, specifically, for elk, has raised emotional and biological concern. In general, the legally supported interpretation of these rights has led to implementation of management actions on both the habitat and populations. These decisions are often site-specific and deal with primary issues like access and compensatory regulation changes.

Suggested Correlates:
- tribal ownership patterns
- treating hunting rights boundaries
- proximity of National Forests
- summer-fall range
- winter range
- road density

Selected References:
Johnson (1990)
Peterson (1994)
Skates (1994)

Related
INTERMINGLED OWNERSHIP/PRIVATE LANDS

Throughout the CRB there are situations where Federal public lands are mixed with or surrounded by or adjacent to private lands. Private land ownership ranges from single family ownership of small parcels adjacent to public lands to large corporate entities that manage their lands for a variety of products. This mixed ownership pattern and mixed set of management objectives creates a whole gamut of difficult management situations for the public land manager, especially within the context of a highly mobile and large animal like elk.

Management decisions on private lands may benefit or negate the management for elk on public lands. Issues involved are competition for forage with domestic livestock, utilization of agricultural crops for forage, hunting, occupation of private lands which offer high security, private use of a public resource, and damage to private improvements (for example, . fences). The specific issue and its magnitude is highly variable across the CRB, but the crux of the issue is usually the extent of movement by elk off public lands and onto private lands.

Managers need to understand the distribution of elk and elk habitat across public lands and within the context of patterns of private land ownership. Managers also need to understand state management objectives for elk and the goals of private land owners for their lands.

Suggested Correlates:

- ownership patterns
- private corporate management objectives
- summer/fall range
- winter range

Selected References:
Jones and Bower (1991)

5) HABITAT MODELS FOR ELK

"The purpose of building models is not to mimic nature, but to enable one to think usefully about a problem." (Starfield and Bleloch 1986). In elk habitat management, the problem is to assure that appropriate combinations of water, food, and cover are present within a spatially defined area, and that the resulting environment is available to elk that choose to use it. Elk habitat models of elegant simplicity and great complexity have been developed. And, while some models have attempted to mimic nature through increased complexity, the evidence suggests that all models are about equally effective in the ability to focus on the inherent capability of the land to sustain elk.

The basic format for all elk habitat models, presented in Thomas et al. (1976), has been developed and modified by other biologists (Thomas et al. 1979, Leege 1984, Lyon 1984a, Lyon et al. 1985, Wisdom et al. 1986, Thomas et al. 1988) and in forest plans. All of these models are essentially similar in that forest cover is maximized near 50 percent, everything not cover is considered forage, and utilization by elk is determined by the number of miles of. open road in the environment. Most models specify an area not to exceed about 6000 ha, which for purposes of the CRB assessment represents a scale too site specific to be acceptable. The utility of elk habitat models is clearly limited by the scale at which they are applied, but the primary driving variables are probably effective at virtually any scale.

At a slightly different scale, but equally important for the management of elk, are models that address the relationship between elk hunters, elk habitat, and elk. Because hunting accounts for the majority of elk mortalities, understanding this relationship is crucial to long term management of elk on public lands. Elk vulnerability models are inherently complex because they must attempt to expose the basic predator:prey relationship between man and elk within the context of modified habitats, regulated seasons, technological advances, and human behavior as modified by these variables. As a result of an elk vulnerability symposium held in 1991 (Christensen, et al.), we know that high levels of habitat security can protect elk when seasons and hunter numbers are controlled. We know that increased access directly reduces elk survival. We know that increased hunter numbers will eventually overwhelm habitat considerations and lead to the mortality of all targeted animals. We know that hunting opportunity with modern weapons during times of high natural elk vulnerability (for example, . rut, winter) will lead to high mortality of targeted animals.

Models that can help us understand this complex interrelationship of biological and social factors are only now being developed. However, land managers do have several clear parameters they must be cognizant of: 1) low levels of motorized access will enhance bull elk survival, 2) landscapes that include large, interconnected patches of forest cover will enhance bull survival, 3) combinations of terrain features and vegetative cover can be identified which enhance bull survival. This information is sufficient to develop initial perspectives on our ability as land managers to provide adequate habitat for elk to survive regulated hunting. The current literature describing vulnerability models is not geographically oriented, and, unlike the habitat models, vulnerability models are probably equally effective at any scale.

Selected References:
Christensen et al. (1991)
Leege (1984)
Lyon (1984a)
Lyon et al. (1985)
Starfield and Bleloch (1986)
Thomas et al. (1976)
Thomas et al. (1979)
Thomas et al. (1988)
Wisdom et al (1986)

6j SUMMARY

Within the CRB, elk embody significant social, economic, and ecological values. Rebounding from near extinction in the late 1800s to today's large and expanding populations, elk represent a major success story in wildlife management. The revival in elk numbers was the result of active reintroduction, control of hunting, improved land management, and support from hunters. There has been a long history of involvement by hunters/citizens which partially explains the very strong social support that elk receive in the CRB. The pursuit of elk by hunters or by those only interested in seeing elk represents a huge economic benefit to many communities throughout the CRB. Based on figures compiled in 1991 (USFWS 199-) expenditures and viewing and hunting elk exceeded ??500 million. In several western states, hunting license sales for elk represent the single largest source of income for the state game department.

The combination of high public recognition and support for elk and the significant economic benefits associated with elk are largely responsible for elk being a major management consideration on public lands. Additionally, given the fact that elk are largely a species of the West where they occur predominantly on public lands, elk management is an issue in which any citizen has a bonifide stake. Considerations for elk and the primary elk issues have received repeated and detailed analysis in public land management plans.

Biologically, elk have received intensive study over a long period of time. Few species of wildlife have been the target of such a large and successful research and management campaign. The biological needs of elk are well understood and have received endorsement and financial support from state and federal managers. So successful have some state programs become that one element of today's management problem is the presence of too many elk, as indicated by depredation problems.

In the face of major land use changes, expanding human populations, active extraction of commodity resources on public lands, and increased harvest and hunting opportunity, elk have increased in numbers and expanded their range in'most of the CRB during the past 50 years. Elk management problems have shifted from managing for any elk to managing for desirable bull:cow ratios, from managing winter ranges to managing ranges for all seasons, and from a strictly habitat focus to a habitat:hunting mortality complex.

While there are some areas where elk numbers and habitat have recently declined within the CRB, it is nevertheless accepted that given reasonable management consideration, elk are adaptive and resilient and do not represent a species within the CRB that constitutes a sensitive barometer of change. In fact, within the CRB, elk represent a species that offers abundant management options and relative compatibility with traditional management activities on public lands. Based on well understood habitat relationships, elk can be weighed and considered in land use decisions with a high degree of confidence that decisions can be implemented successfully.

Less predictable are social factors that result in direct reductions in elk habitat, intolerance for elk on private lands, increased disturbance of elk habitat, and a shrinking base of citizens that are directly knowledgeable or that interact with elk. For these reasons, the management of elk habitat on public lands gains ever growing significance. For most people in the future, the desire to see, hunt or otherwise enjoy elk will be fulfilled on public lands. Therefore, despite a brilliant recovery from near extinction in this century and the perspective that elk will adjust to nearly any habitat scenario, it will take the careful management of public lands to ensure the future for elk.

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1) PREAMBLE FOR UNGULATE ASSESSMENT: Mule Deer in the CRB

The mule deer, of which the sub specific form blacktail deer must be considered an extension of the species, is perhaps one of the greatest habitat generalists know to game managers. Mule deer occupy almost every habitat within the CRB. The blacktail deer is distributed westward from the CRB, occupying the area west of the Cascade mountains from northern Alaska to southern California. These two deer, mule and blacktail, interface, and inter-breed, along portions of the eastern side of the Cascade Mountains. These hybrids can be observed on the Okanogan, Wenatchee, Mt. Baker Snoqualmie, Mt. Hood, Deschutes, Willamette and Winema National Forests.

Mule deer are a common component of the forested ecosystems within the CRB, the blacktail is not, and for purposes of this assessment probably should not be considered. Mule deer are a successful habitat generalists, occupying every forest type and extending out from the forest types in the shrub steppe and agricultural lands within the Columbia basin. Although mule deer are a successful habitat generalist, species survival, productivity and thrift are directly linked to several habitat variables, which dictate overall population success.

Mule deer are an important social and economic resource within the CRB. More recreation days, both consumptive and non-consumptive, can be attributed to mule deer within the CRB than any other deer species. Many small communities throughout the CRB depend upon the income from mule deer hunters for economic survival. Within many small communities the small business owner barely survives on general year long income, the deer hunter provides the profit margin portion of their annual income.

The species is also an important food supply for large predators, mountain lion in particular, and a variety of small mammalian predators, carrion feeders, and birds, Golden eagle, bald eagle, coyote, bobcat, and bear rank among the top dependent predators.

2) DEFINITIONS: ISSUES AND CORRELATES

ISSUE is any consideration, usually created or controlled by man, that has 1) a direct influence on the ungulate species, or 2) on the distribution of the ungulate species, or 3) on the environmental correlates that influence the fitness of the species.

Primary issues are those elements of species or habitat management that can specifically define and control population numbers or habitat over time. In virtually all cases, primary issues will emerge from the careful analysis of site-specific opportunities, problems or concerns. Primary issues constitute the basic, relevant parameters that can be used on a landscape basis to understand the species and habitat relationships. They are generally biological in nature and can be quantified, observed, and modelled.

Related issues are those that bring context and site specific resolution to the species and habitat situations. They are generally social in nature and influence the primary biological elements either positively or negatively. Related issues are frequently the starting point in management consideration, but generally must be reduced to primary issues in order to identify implementable actions. There are usually a strong interactive relationships between primary and related issues.

Correlates are any factor that affects the distribution, abundance, and fitness of a species. In the context of application to CRB, correlates are of two types:

- Those that identify spacial relationships of issues, especially of primary issues.
- Those that identify environmental features of species habitats.

Correlates should be detectable as a surface feature on the GIS coverages available for CRB analysis. Habitat correlates often answer questions about the niche filled by the species, or the evolutionary function served. They should identify landscape suitability characters and species limitations related to terrain and weather.

3) LIST OF ISSUES AND CORRELATES

Primary:

forage
snow depth
competition (cattle, sheep)
fire management
logging
urban development

Related:

road access
poaching
domestic dogs
highways
vehicle mortality

4) BRIEF, OBJECTIVE STATEMENT ABOUT EACH ISSUE

The purpose of this section is to clearly identify each issue and the associated correlates and to provide a few key literature citations. We attempt to be completely generic and describe the situation without being judgmental.

In most cases these are issues because they affect the species or species habitat, and because they are action items for the Forest Service and/or BLM. Each issue has a geographic context: it is important throughout the Columbia Basin, or it is more localized. If localized it is important everywhere, or it is more important some places than others.

Primary
FORAGE

Reproductive and survival thrift, for mule deer, is achieved when the species has a full range of seasonal ranges available that provide for growth and reproduction, The species migrates, on most ranges, from summer/fall ranges to lower elevational winter/spring ranges. Frequently, these two distinct ranges are some distance apart and represent a variety of land ownership patterns and management. A significant portion of the mule deer summer range is public land, National Forest or Bureau of Land Management. The Bureau also has mule deer winter range habitat, whereas the Forest Service less frequently supports mule deer winter range. A significant portion of the species winter ranges are within the private sector on agricultural lands. Often, winter range is considered a limiting factor without which mule deer survival would be difficult. The truth, however, is that winter range is simply an extension of the species forage needs into the winter period where forage is no less important than summer forage. The prime difference is winter mortality is observable and emotional where deer are concentrated.

Key forage species for mule deer are provided by early seral stage plant communities that provide a variety of forage to meet species energy demands that change seasonally throughout the year. Although mule deer are frequently viewed as a shrub dependent species, shrub ranges do not provide the full spectrum of forage needs required to support the species.

Suggested correlates:

- acres logged annually
- acres burned annually (Rx and wild fires)
- miles of road on winter ranges
- population density (humans) on winter range

Selected References:

Anderson, Allen E. and Olof C. Wallmo. 1984. Odocoileus hemionus. in Mammalian Species No. 219, pp. l-9. Pub. by Amer. Soc. of Mamm.

Mackie, Richard J., Kenneth L. Hamlin and David F. Pac. 1982. Mule Deer. in Wild Mammals of North Amer. Biology, Management and Economics. pp.862-877. ed. by Joseph A. Chapman and George A. Feldhamer, pub. by Johns Hopkins Univ. Press.

Primary
SNOW DEPTH

Snow depth and condition of the snow play a deciding role in the survival of whitetail deer within the CRB. Although the species in general does not exhibit extensive movement between seasonal ranges, elevational movements are common in response to snow conditions. Snow physically covers important forb and grass species and beyond a certain depth energy demands for locomotion require additional energy expenditures. Crust on snow significantly impairs the species ability to find forage, restricts movement, and can contribute mechanical damage to the lower legs.

Suggested correlates:

snow depth 20 inches

Selected References:

Carpenter, Len H. and Olof C. Wallmo. 1981. Part'2. Habitat Evaluation and management. in Mule and Black-tailed Deer of North America. Chapter 10 pp. 399-421. Pub. by WMI.

Primary
COMPETITION WITH LIVESTOCK

Primary competition from cattle occurs because of season long overstocking, or-grazing systems that force cattle to utilize all available forage supplies in particular summer range areas. Late season or early season use'of winter range areas by cattle usually forces cattle to remove the most nutritious species, either in total plant mass or re-growth, leaving nothing for winter forage supply.

Sheep are a direct competitor for the same forage species that produce mule deer, forbs, sedges and early grass growth. Early shrub production is also removed.

In general, grazing by cattle and sheep can be beneficial to mule deer ranges if grazing is conducted to maintain a spectrum of early seral stage forbs.

Suggested correlates:

acres of sheep allotments
acres of cattle allotments

Selected references:

Mackie, Richard J. 1981. Interspecific Relationships. chap. 13 pp. 487-507. in Mule and Black-tail Deer of North America. ed. by Olof C. Wallmo. pub. by WMI.

Primary
FIRE MANAGEMENT

The exclusion of wildfire from the CRB forested habitats has contributed significantly to a decline of palatable deer forage in the form of early successional state plants. Managed fire, or prescription fire, applied commensurate with the ecological parameter of existing vegetation can enhance primary deer forage.

Suggested correlates:

acres Rx fire
acres wild fire

Selected references:

Wallmo, Olof C., Albert LeCount and Sam L. Brownlee. 1981. Chap. 9, Part 2. Habitat Evaluation and Management. in Mule and Black-tailed Deer of North America. pub. by WMI.

Primary

LOGGING

The primary habitat variable that sustains mule deer populations is constant change in the structure and composition of the plant communities comprising the species habitat. This constant change can be brought about by logging, fire (Rx and wild), grazing, and insects / disease. The constant change is vegetation structure and composition is necessary because the window of forage productivity for mule deer following disturbance of plant communities is short in duration. Within the CRB the window of forage production can vary from 3 to 10 years, depending upon the type of disturbance and the plant community affected.

Within forested ecosystems, during the last 30 years, logging has been the primary disturbance factor that causes the early successional plant composition necessary for productive mule deer habitats, Unfortunately, most logging has been done without considering or planning for mule deer habitat. Equally unfortunate, mule deer benefitted from increased production on summer ranges as a result of logging, but the winter ranges shared no equal consideration or habitat maintenance. Thus, only one-half of the mule deer forage equation was completed.

Suggested correlates:

acres of logging within the “window of forage productivity”

Selected references:

Carpenter, Len H. and Olof C. Wallmo. 1981. chap 10, Part 2. Habitat Evaluation and Management. in Mule and Black-tailed Deer of North America. pp. 399-421. ed. by Olof C. Wallmo. pub. by WMI

Primary
URBAN DEVELOPMENT

Population expansion by humans is probably the most serious threat to mule deer habitat. Urban development frequently inter-faces with mule deer range, summer and winter, and migration routes. In many examples throughout the CRB mule deer range has been lost to development of urban areas for permanent residents or in conjunction with recreational sports, e.g. ski areas, summer cabins.

Suggested correlates:

Population density (human) per sq. mi. of deer range
miles of road per sq. mi. of deer range

Selected references:

Reed, Dale F. 1981. chap. 14. Conflicts with Civilization. in Mule and Black-tailed Deer of North America. ed. by Olof C. Wallmo. pp. 509-535.

Related
ROAD ACCESS

A common source of disturbance to members of the deer family, mule deer included, is vehicle travel. Roads, or miles of road per sq. mi. of deer habitat, is only a measure of the causative agent, vehicle travel. In conjunction with vehicle travel, or miles of roads, is the almost unmeasurable disturbance caused by off-road-vehicle (ORV) travel. As a result deer are displaced from portions of their historic ranges. On winter ranges, the loss of energy from expenditures to escape the disturbance and loss of foraging opportunity frequently results in mortality, both to adults and fawns “in the carry”.

Selected references:

Reed, Dale F. 1981. chap. 14. Conflicts with Civilization. in Mule and Black-tailed Deer of North America. ed. by Olof C. Wallmo. pp. 509-535.

Related
POACHING

Until recent years, poaching was not included in population management. It is now known that illegal harvest, of which poaching is a significant percentage, accounts for a significant part of the annual mortality. Whitetail are probably less susceptible to poaching due to their restricted habitats and shy habits, but it is likely a significant mortality factor.

Suggested correlates:

Miles of road / sq. mi. deer habitat
Human population density

Selected references:

Connoly, Guy E. 1981. Assessing Populations; in Mule and Black-tailed Deer of north America. ed. Olof C. Wallmo. pp 287-346.

Related
DOMESTIC DOGS

Human habitation is expanding into deer habitat, as a consequence of more people occupying the land and the popular trend to move away from large metropolitan developments and “live on the land”. Characteristically, people that move to the “urban” areas have dogs which run free. Interactions with deer, particularly in the winter when the animals are restricted by space, snow depth, and forage resources, harassment by dogs can be particularly devastating.

Selected references:

Reed, Dale F. 1991. Conflicts with Civilization; in Mule and Black-tailed Deer of North America. ed. Olof C. Wallmo. pp. 509-536.

Related

HIGHWAYS

VEHICLE MORTALITY

These were both listed in the short list, but were not discussed or explained in the expanded section of the assessment.

5) HABITAT MODELS

Within the CRB there is only one model that approaches habitat evaluation for mule deer. There are no habitat models for whitetail deer.

The single mule deer model was developed in the Klamath Basin by personnel form the USDA Forest Service, Winema National Forest and Fremont National Forest and Craig Beinz, Klamath Tribal biologist. The model is currently being validated, under contract to Dr. Jim Peek, University of Idaho and Terry Hershey, Forest Biologist, Fremont National Forest.

Although no model was furnished or discussed, the following correlates are suggested as a part of discussion under ISSUES

Correlates:
Forested land
summer range
    logging
winter range
    fire
    urban interface
    snow depth

6) SUMMARY

No summary was provided by the original author of this section

1) PREAMBLE FOR UNGULATE ASSESSMENT: Whitetailed Deer in the CRB

The deer family, particularly the whitetailed and mule deer, played an important role in the development of this country and providing food and clothing for Native Americans, explorers, trappers and settlers. Deer skins and venison were important in the early economics of the intermountain west. Prior to the 1960's, when mule deer populations collapsed throughout the intermountain west and elk became a premier species, these two deer species were considered to be the “bread and butter” of the State Game Departments, which are primarily dependent upon the sale of license and tags for operating revenue. At one time, in the history of the CRB, deer tag sales far outnumbered all other big game tag sales.

Whitetailed deer within the CRB have played a less significant role than mule deer primarily because of their distribution. Prior to the 1960's, this species primarily affected the economics, hunting sports, and ecological impacts to vegetation in the upper drainages of the Columbia River and the tributaries of the Snake River. Since that time whitetailed deer have expanded from a once restricted range along the Wenaha River and the Umatilla Basin in NE Oregon to basins including the Powder River, Grande Rhonde, John Day and Katherine Creek in Oregon. In Washington, the species has expanded from the NE corner of the state westward to the Okanogan and Wenatchee National forests. But even with this expanded distribution, the species is still a minor component of the total harvest of deer. Special hunts are a common management technique used by the state game departments attempting to get utilization on this species.

Whitetailed deer occupy a separate niche from the more common mule deer, apparently finding the riparian zones, brushy draws, and agricultural lands a place where they can successfully compete for forage and space. Changes in land use management and forest management have contributed to this expansion by creating living space and a forage supply. Cutting units have provided a source of early seral stage forbs, grasses, and shrubs which have allowed the species to expand their range. In the Blue mountains of NE Oregon, whitetail/mule deer crosses have been noted where their ranges overlap. But, neither species seems to be significantly successful in the forested habitats above the shrub steppe habitats or agricultural mosaic of varying farm crops.

The species does provide a prey base for large predators; bear, cougar, wolf, coyote, bobcat and a large variety of small predator/carrion feeding mammals and birds.

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Primary issues are those elements of species or habitat management that can specifically define and control population numbers or habitat over time. In virtually all cases, primary issues will emerge from the careful analysis of site-specific opportunities, problems or concerns. Primary issues constitute the basic, relevant parameters that can be used on a landscape basis to understand the species and habitat relationships. They are generally biological in nature and can be quantified, observed, and modelled.

Related issues are those that bring context and site specific resolution to the species and habitat situations. They are generally social in nature and influence the primary biological elements either positively or negatively. Related issues are frequently the starting point in management consideration, but generally must be reduced to primary issues in order to identify implementable actions. There are usually a strong interactive relationships between primary and related issues.

Correlates are any factor that affects the distribution, abundance, and fitness of a species. In the context of application to CRB, correlates are of two types:

- Those that identify spacial relationships of issues, especially of primary issues.
- Those that identify environmental features of species habitats.

Correlates should be detectable as a surface feature on the GIS coverages available for CRB analysis. Habitat correlates often answer questions about the niche filled by the species, or the evolutionary function served. They should identify landscape suitability characters and species limitations related to terrain and weather.

Primary issues
    Correlates for each issue
Related issues
Habitat correlates

3) LIST OF ISSUES AND CORRELATES

As compared to the sections which follow, this section is intended to provide a brief, executive summary:

Primary:

forage
snow depth
competition (moose, elk, livestock)
fire management
logging

Related:

- urban development
- farm practices
- road access
- poaching
- domestic dogs

4) BRIEF, OBJECTIVE STATEMENT ABOUT EACH ISSUE

Primary
FORAGE

With exceptions, whitetail deer forage resources are not subject to large scale land management activities that would significantly alter forage supplies for this species. Within the CRB the primary niche for whitetail deer appears most commonly as agricultural lands which provide inclusions of old field succession, or isolated parcels of early seral vegetation and/or shrub dominated non-managed lands. Riparian zones isolated from human disturbance and relatively free of livestock use most are "connector" habitats and winter survival habitat.

Within the CRB the most important food items would appear as shrub species in the following genera; Symphoricarpus, Ceanothus, Prunus, Cornus, Berberis, Pinus, Populus, Rhus, and a variety of forbs and grasses

Suggested Correlates:

- shrub fields
- riparian zone
- abandoned farm fields

Primary
SNOW DEPTH

Snow depth and condition of the snow play a deciding role in the survival of whitetail deer within the CRB. Although the species in general does not exhibit extensive movement between seasonal ranges, elevational movements are common in response to snow conditions. Snow physically covers important forb and grass species and beyond a certain depth energy demands for locomotion require additional energy expenditures. Crust on snow significantly impairs the species ability to find forage, restricts movement, and can contribute mechanical damage to the lower legs.

Suggested correlates:

snow depth 20 inches

Primary
COMPETITION (moose, elk, livestock)

Within the CRB where moose (Alces) are established, direct competition can be expected for forage in the riparian / wetland habitats occupied by both species. Elk are less significant as a competitor, but during winter periods when elk are forced into lowland, shrub draws and riparian zones, direct competition can occur. Livestock, horses, cattle and sheep when grazed in the ecotones supporting whitetail deer also compete for the same forage base.

Suggested correlates:

- Moose range
- Livestock allotments
- Elk winter range

Primary
FIRE MANAGEMENT

The exclusion of wildfire from the CRB forested habitats has contributed significantly to a decline of palatable deer forage in the form of early successional state plants. Managed fire, or prescription fire, applied commensurate with the ecological parameter of existing vegetation can enhance primary deer forage.

Correlates:

- acres prescribed fires
- acres wild fire

Primary
LOGGING

Removal of the montane forest canopy, both within the yellow pine zone and the upper elevation true fir zone have created a mosaic of early successional stages providing forage opportunities for whitetail to extend their range out of the valley agriculture lands across forested barriers and into such valleys as the Grand Rhonde, Baker and John Day valleys. Sightings of mule deer / whitetail crosses in the Blue Mountains in the 1970s would indicate this has been the range extension method in NE Oregon. The proportion of yellow pine that contributes to their winter diet would also indicate that logging has provided forage opportunities for whitetail. The recent decline in logging activity on federal lands will now have the opposite effect on whitetail deer habitat capability.

Suggested correlates:

Acres logged within 3-5 yrs. (within the Pipo assoc. within WT range)

Related
URBAN DEVELOPMENT

Society's movement away from population densities and into the urban/wildland interface has probably had more impact on the deer species than any other single man caused activity. Whitetail are particularly vulnerable as urban development tends to localize around water courses, a prime source of whitetail habitat. Abandoned farmsteads are also prime development lands and with the urban dwellers attachment to dogs and horses, whitetail are displaced from their small inclusive habitats. Federal lands are less susceptible to developments on a broad scale, but recreation areas are often located in riparian zones. The resultant disturbance factor caused by human/dog presence soon displaces the whitetail.

Suggested correlates:

Number of homes/cabins per square mile adjacent to federal lands.
Number of recreation sites per mile of riparian corridor
Season of use at recreation sites
Miles of road

Selected references:

(none that I am aware of)

Related
FARM PRACTICES

Agricultural practices adjacent to forested lands or riverine systems which benefit whitetail are row crops, hay, corn, alfalfa, and peas. The ratio of undisturbed lands; shrub fields, riparian corridors, old field succession are important habitats when in juxtaposition to managed lands. Federal lands are not conducive to these kinds of habitat management.

Suggested correlates:

Acres of particular crop lands (those listed)
Ratio of developed agricultural lands to successional whitetail habitat

Related
ROAD ACCESS

Roads subject to vehicle travel are a constant source of disturbance, particularly for the deer species. Vehicles and their related human conflicts brought into deer habitat significantly alter the usability of that habitat.

Suggested correlates:

Miles of road open to vehicle travel/sq. mi. of whitetail habitat

Selected references:

Related
POACHING

Until recent years, poaching was not included in population management. It is now known that illegal harvest, of which poaching is a significant percentage, accounts for a significant part of the annual mortality. Whitetail are probably less susceptible to poaching due to their restricted habitats and shy habits, but it is likely a significant mortality factor.

Suggested correlates:

Miles of road/sq. mi. deer habitat
Human population density

Selected references:

Connoly, Guy E. 1981. Assessing Populations; in Mule and Black-tailed Deer of north America. ed. Olof C. Wallmo. pp 287-346.

Related
DOMESTIC DOGS

Human habitation is expanding into deer habitat, as a consequence of more people occupying the land an'd the popular trend to move away from large metropolitan developments and "live on the land". Characteristically, people that move to the "urban" areas have dogs which run free. Interactions with deer, particularly in the winter when the animals are restricted by space, snow depth, and forage resources, harassment by dogs can be particularly devastating.

Selected references:

Reed, Dale F. 1991. Conflicts with Civilization; in Mule and Black-tailed Deer of North America. ed. Olof C. Wallmo. pp. 509-536.3) LIST OF ISSUES AND CORRELATES

5) HABITAT MODELS

No habitat model was provided or discussed other than to mention under mule deer that no models had been developed. The primary issues listed for whitetailed deer suggest the following correlates for CRB habitat.

Jageman (1984) indicates winter ranges are in riparian areas on south slope. Dense conifer cover is preferred. Summer range is less restricted but is also riparian, with small openings (<20a) conifer cover (70%)

Correlates:

- riparian zones
- conifer cover >70%
- brushy draws
- agricultural lands
- snow depth

Jageman, Harry. 1984. White-tailed deer habitat management guides. Bul.No. 37. Forest, Wildl. and Range Exp. Station, University of Idaho, Moscow. 14p.

6) SUMMARY

No summary statement was provided by the original author

1) PREAMBLE FOR UNGULATE ASSESSMENT: BIGHORN SHEEP

Lands managed by the federal government provide habitat for a majority of the bighorn sheep (Ovis sanadensis ssp.) in the Columbia River Basin (CRB). Two subspecies are native to the CRB; the California bighorn (O. c. salifomiana) found in eastern Washington, eastern Oregon, north eastern Nevada, and southwestern Idaho, and the Rocky Mountain bighorn (O. c. canadensis) native to western Montana, north and 'central Idaho, and western Wyoming. The California bighorn is listed as a C2 species (candidate for T&E listing) by the US Fish and Wildlife Service, a sensitive species in Idaho and Oregon by the US Bureau of Land Management and by the US Forest Service Region 6. Bighoms are considered high profile animals by sportsmen, wildlife interest groups, as well as the general public. To the several million people that annually visit the CRB for an outdoor experience the bighorn signifies wilderness, freedom, and regal beauty matched by few other wildlife species.

The number of bighorns in the CRB is low when compared to deer and elk populations, resulting in a conservative harvest program based on permits issued to applicants successful in a random drawing. Demand for the limited number of permits is high - averaging 20-30 applicants for each available permit. Most states make one or more permits available by auction to the highest bidder or as a raffle item. The amount bid for an auctioned permit has ranged from $50,000 to over $300,000. With most of the money returned to the state for bighorn management programs. The CRB bighorn populations have supplied large numbers of sheep for re-introductions within and outside of the CRB and currently supply the only source of California bighorns available for transplanting. The 1991 USFWS economic survey on hunting and fishing in the CRB estimated that expenditures in 1990 (91?) for bighorn hunting totaled about $....... and for viewing bighoms $..... .

Bighorns serve a number of ecological roles within the CRB. They act as a prey species for predators such as mountain lion, bobcats, coyotes, golden eagles and the recently re-introduced and endangered gray wolf. As carrion, bighoms provide a source of food for a host of mammalian and avian predators. They also act as part of the ecosystem by interrelating with other ungulates in the use of commonly shared habitats.

Approximately 5,000 California and 15,000 Rocky Mountain bighoms currently occupy federally owned habitat within the CRB. An unknown but substantial amount of additional vacant habitat exist within the CRB. State wildlife management agencies estimate that sufficient vacant historic habitat exists to double or triple the number of bighorns within the CRB. Management activities such as livestock grazing, mining, fire management/suppression, timber harvest, and recreation site development can be done in a manner that minimizes negative effects on bighoms, and maintains or improves habitat suitability. An understanding of the interactions between bighorn and human demand for resource use can assist the manager in meeting land management goals. This document provides the primary issues, habitat correlates and a basic understanding of bighorn / habitat interactions needed for a landscape assessment in the CRB.

2) DEFINITIONS: ISSUES AND CORRELATES

ISSUE is any consideration usually created or controlled by man that has 1) a direct influence on bighorn sheep, or 2) on the distribution of bighoms, or on the environmental correlates that influence the fitness of bighorn sheep.

Primary issues are those elements of species or habitat management that can specifically define and control population numbers or habitat over time. In virtually all cases, primary issues will emerge from the careful analysis of site-specific opportunities, problems or concerns. Primary issues constitute the basic, relevant parameters that can be used on a landscape basis to understand the species and habitat relationships. They are generally biological in nature and can be quantified, observed, and modelled.

Related issues are those that bring context and site specific resolution to mountain goat and goat habitat situations. They are often social in nature and influence the primary biological elements either positively or negatively. Related issues are frequently the starting point in bighorn sheep management considerations, but generally must be reduced to primary issues in order to identify implementable actions.

Correlates are any factor that affects the distribution, abundance, and fitness of a species. In the context of application to CRB, correlates are of two types:

- Those that identify spacial relationships of issues, especially of primary issues.
- Those that identify environmental features of species habitats.

Correlates should be detectable as a surface feature on the GIS coverages available for CRB analysis. Habitat correlates often answer questions about the niche filled by the species, or the evolutionary function served. They should identify landscape suitability characters and species limitations related to terrain and weather.

3) LIST OF ISSUES AND CORRELATES

Primary:

Diseases
Grazing/livestock
Vegetational manipulation
Human disturbance
Vacant habitats
Key habitats
Wilderness management
Models/management guidelines

Related:
Cooperative efforts with state wildlife management agencies

4) BRIEF, OBJECTIVE STATEMENT ABOUT EACH ISSUE

PRIMARY: Diseases

Bighorn populations are sometimes subjected to severe reductions from endemic and non-endemic disease related problems (Bailey 1936, Onderka and Wishart 1984, Coggins 1988, Spraker and Adrian 1990) and disease rather than carrying capacity may be the major limiting factor for bighorns (Dunbar 1992). Disease caused reductions have reduced hunting and viewing opportunities and in some cases jeopardized the existence of small bighorn herds in the CRB. Bighorns are vulnerable to transmission of many non-endemic diseases from domestic ruminants. These include viral, chlamydial, rickettsial, bacterial, and parasitic diseases (Spraker and Adrian 1990). Bighoms are especially susceptible to pneumonia caused mortality from non-endemic strains of viruses (primarily Pasteurella hemolytica and Parainfluenza type-3) transmitted by domestic sheep. Mortality rates of 25 to 100% of the exposed bighorn population have been reported (Foreyt and Jessup 1982, Foreyt 1989, and). Research results recommend that bighorn sheep and domestic sheep be restricted from use of the same habitats (Spraker and Adrian 1990,).

A substantial amount of vacant and otherwise suitable bighorn habitat exists on domestic sheep allotments in the CRB. The current literature suggests less concern for disease transmission from cattle, although cattle are a host to Bluetongue, a potentially severe disease in bighoms (Spraker and Adrian 1990).

Suggested correlates:
Occupied and vacant bighorn habitat
Domestic sheep and/or goat allotments
Other domestic livestock allotments

Additional references of interest:
Hudson 1972
Goodson 1982
Festa-Bianchet and Samson 1984
Onderka and Wishart 1984
Foreyt et al. 1990
Akenson and Akenson 1992
Foreyt 1992
Ryder et al. 1992

PRIMARY: Grazing/Livestock

Livestock grazing on or near bighorn habitats can have positive (Bodie and Hickey 1982) or negative effects on bighorn populations. Negative effects occur in 4 broad categories (Spraker and Adrian 1990); disease transmission (discussed in the previous section), competition for resources (Van Dyke et al. 1983), social intolerance (King and Workman 1984), and inter-breeding with domestic sheep (Spraker and Adrian 1990). Competition for resources resulting in negative population effects is difficult to measure. Generally, bighoms use habitats with high percent slopes unusable by cattle. Competition can occur in high mountain meadows and on flat areas adjacent to bighorn escape and/or lambing. cliffs used by cattle or domestic sheep. Light or moderate late summer cattle grazing on bighorn winter ranges may increase winter bighorn use (Bodie and Hickey 1980). Livestock grazing intensities that change climax grasslands to earlier successional stages normally reduces the quality of available forage for bighoms (Van Dyke et al. 1983).

Social intolerance between bighorns and livestock has caused reduced use by bighoms of areas near water holes and riparian areas (King and Workman 1986) or increase stress resulting in increase disease related mortality (Dunbar 1992). Reduction of grazing intensities or elimination of grazing allotments for bighorn habitat improvement has resulted in controversy that has sometimes been highly emotional and political in nature.

Suggested Correlates:
Livestock allotments, sheep
Livestock densities
Vegetation utilization
Water sources

Additional references of interest:
Goodson 1982
Hudson 1992

PRIMARY: Vegetational manipulation

Man caused changes in the composition or structure of the vegetational component of bighorn ranges can alter distribution, forage quality and quantity, or the health and productivity of bighorn populations. Research studies have shown both positive and negative effects on bighoms from changes in habitat. Wakelyn (1984) suggested habitat loss due to vegetational succession (conversion of grass or grass/low shrub communities to tall shrub or timbered community types) was associated with the decline or extinction of 36 herds of bighorn sheep in Colorado. Prescribed and managed wild fires (Peek et al. 1979, Hobbs and Spowart 1984, Cook et al. 1990), and timber harvest (Yde et al. 1986, Young and Yde 1988) can improve habitat conditions by increasing the quantity and quality of grass/forb forage and increase visibility by removing trees and tall shrubs. Bighorns select habitats where visibility is high because early detection of predators can' increase survival (Berger 1978, Riser-hoover et al. 1985). An increase in available habitat can temporarily reduce bighorn densities which can reduce density dependent stress and the resultant increase in disease related mortality. These factors can ultimately result in increased populations (Spraker and Adrian 1990). In comparison to deer and elk, bighoms avoid areas with high timber or brush cover and use physiographic features such as cliffs for escape and thermal cover (Geist 1971).

Vegetative manipulation projects, especially seedings that convert climax or near climax grass stands into non-native mono-cultures, reduce forage availability. Prescribed and natural fires as well as livestock grazing can convert climax grasslands or mixed shrub/grasslands into habitats dominated by undesirable species such as cheat grass or big sage in some habitat types.
In other vegetative types fire can increase grass vigor and visibility by removing tall shrubs or timber.

Suggested correlates:
Climax grasslands or mixed shrub/grasslands .
Habitat with vegetation exceeding 36"
Livestock allotments
Area burned, seeded, grazed or logged

Additional references of interest:
Shannon et al. 1975
Wright and Bailey 1982
Wakelyn 1987
Amett et al. 1990
McWhirter et al. 1992

PRIMARY: Human disturbance

Recreation, management, and research activities can alter bighorn behavior and habitat use. Human disturbance can affect bighoms by changing distribution (Hicks and Elder 1979, Hamilton et al. 1982) or increasing stress (MacArthur et al. 1982). Factors such as type of disturbance, distance to disturbance, season, and age and sex of bighorns can influence how sheep respond (Horejsi 1976, King and Workman 1986). The relative threat of a disturbance may also influence their response. Hunted populations responded more strongly to disturbance than non-hunted populations (Hicks and Elder 1979, Leslie and Douglas 1980, Hamilton et al. 1982, Bleich et al. 1990). Populations subjected to low level helicopter surveys or helicopter capture activities may respond more strongly than other populations. Humans on foot (Bodie pers. comm), low flying fixed-wing aircraft, and helicopters (Bleich et al. 1990, Bodie et al. 1995) elicit strong reactions from bighoms. Management activities such as heavy equipment activities, vegetational manipulations, mining, or activities that increase exposure time to humans or livestock, may increase predation rates on new born lambs or increase energy consumption for nutritionally stressed animals during severe winters, or to pre-parturient ewes.

Suggested correlates:

Terrain features, slope, and relief (escape terrain)
Proximity to human developments or activities
Areas of winter range or lambing/lamb rearing areas
Number and location of low level fixed-wing and helicopter overflights

Additional references:

Geist 1971
Hansen 1982
Tilton and Willard 1982
Krausman and Hervert 1983
Van Dyke et al. 1983
Wakelyn 1984
Stockwell 1991

PRIMARY: Vacant habitats

Most Rocky Mountain sheep populations declined or were extirpated during the latter part of the 19th century and the early part of the 20th century (Buechner 1960). Losses were rapid and widespread with entire subspecies wiped out. Seaton (1929) estimated that populations had declined from about 1.5 million to less than 30,000 during this period. Diseases introduced by livestock, competition for forage with unregulated livestock grazing, and meat hunting are generally believed to be the causes of the declines. Restrictive hunting regulations and improved range conditions through better grazing management allowed populations to increase by 1960.

Trapping and reintroduction of bighoms to native ranges have improved populations in most western states. Reintroduction of California bighorn sheep in Idaho, Oregon, Washington, Nevada, and North Dakota have increased California bighorn populations from near 0 in 1960 to over 5,000 in 1995. Rocky Mountain bighorns have also increased substantially during this period.

A substantial number of suitable and vacant habitats exist for future transplants and a large amount of historic habitat is not suitable for, reintroduction. Many transplants have failed in these areas. Smith et al. (1991) suggests that Utah's failure to successfully transplant bighorns are do to: 1) Inadequate qualities of suitable range, 2) severe competition with other ungulates, 3) contact with domestic sheep, 4) improper juxtaposition of key habitat components, 5) inadequate quantities of 1 or more critical seasonal ranges, 6) human harassment. Since most occupied and vacant bighorn habitat is located on federally managed lands, management decisions for these habitats will decide the future of bighorn sheep in the CRB.

Suggested correlates:
Areas of vacant and suitable habitat
Areas of vacant and currently non-suitable habitat
Areas of domestic sheep allotments

Additional references of interest:
Hudson 1972
Goodson 1982
Hicks and Elder 1979
Van Dyke et al. 1981
King and Workman 1984
Foreyt 1988
Smith et al. 1991

PRIMARY: Key habitats

Key habitats are defined as those habitats that are primarily responsible for limiting population size. Degradation of key habitats can cause catastrophic declines in population size or productivity (McWhirter et al. 1992). Winter ranges and pre- and post-lambing areas are normally considered key habitats in the CRB. Winter ranges are normally defined by snow depth, slope, aspect, and the presence of nearby rock cliff escape terrain (Smith et al. 1991). Forage quantity and quality, and snow depth can vary over time and are the major determinants of population densities on winter ranges. Winter ranges that are composed of climax native grasslands or near climax native shrub/grasslands are the most productive (Smith et al. 1991).

Lamb production and survival are largely dependent on the health and vigor of the ewe. Ewes that are in poor condition due to inadequate forage produce fewer lambs and lambs that are more susceptible to pneumonia and other diseases (Ryder et a1.1990). Lambs produced on poor quality lambing habitat (low amounts of steep rock cliffs) with low amounts of forage have increased predation rates. Human activities such as livestock grazing, mining, vegetational manipulation projects, fire suppression, and recreation can negatively impact winter ranges. Prescribed fires, natural fire management plans, and livestock grazing can be designed to improve winter ranges (Hobbs and Spowart 1984). Lambing cliffs are normally too steep for cattle grazing, but not for domestic sheep or goats. The flats within 300 m of lambing areas are important as foraging areas for lactating ewes and can be negatively impacted by livestock grazing or recreation developments (Van Dyke 1983).

Suggested correlates:
Areas of bighorn winter ranges
Areas of bighorn lambing and lamb rearing habitat
Recreation use levels
Grazing allotments and grass utilization rates

Additional references of interest:
Geist 1971
MacArthur et al. 1979
Peek et al. 1979
MacArthur et al. 1982
Amett 1990
Belden et al. 1990
Spraker et al. 1984

PRIMARY: Wilderness management

Wilderness management creates additional management problems above those experienced on non-wilderness lands under federal management. Typically, wilderness management emphasizes natural processes rather than consumptive and non-consumptive uses. In some cases agencies appear naive regarding the dynamics of natural populations and management goals based on these assumptions could jeopardize many herds (Bailey and Woolever 1992). The 11 western states contain more than 287 wilderness areas and 63% are ~50,000 acres. Over 100 contain bighorn sheep (Bailey and Woolever 1992). Most wilderness areas do not have completed management plans. Bighorn management will probably play a major role in most plans.

Wildlife management agencies have expressed concern over the differing restrictions placed on them by the various wilderness managers. As an example, in the 11 western states aircraft for census work are not allowed on 1 forest,: it requires a special decision on 2 forests and throughout 2 Regions: it is allowed on 1 forest and 2 regions. In one case, 4 forests in the same Region have differing restrictions. Differing restrictions for capturing animals from aircraft is even more common (Bailey and Woolever 1992). Similar differences occur with fire management plans. A substantial number of bighoms living in wilderness areas could be made available for transplanting with changes in the policies for aircraft use for wildlife capture. More clear direction and standardization in wilderness policy can improve bighorn habitat management and cooperative management with state agencies.

Suggested correlates:
Management plans coordinated across the CRB
Consistent policies for cooperating agencies
Acres of wilderness
Acres of habitat needed to support MVPs (>150) of bighoms
Acres of habitat improvement needed to support MVP (>150)

Additional references of interest:
Geist 1975
Christensen 1988
Bailey 1992

RELATED:
Federal/state cooperation

Federal and state land and wildlife management agencies have attempted cooperative management efforts for bighorn sheep with varying degrees of success. The large number of involved federal and state administrative units create difficulties in achieving consistent bighorn management plans across the CRB. Usually, the management responsibilities of land and wildlife management agencies differ. Federal land management. agencies commonly manage under a multiple use concept while federal and state wildlife agencies are more single use (wildlife) oriented. Other groups such as state land management agencies, U.S. Bureau of Reclamation, and the various Native American tribal entities emphasis many different management philosophies. These problems can delay or halt needed bighorn habitat and/or population management projects and may jeopardize the existence of small populations (Smith et al. 1991).

In many cases, cooperative efforts between state and federal agencies have been successful if sometimes slow in implementation. The large increases in bighorn numbers over the past 30 years have primarily been due to cooperation in re-introducing bighoms into historic ranges on federally managed lands. Cooperative agreements between state and federal agencies that provide bighorn population goals and the means to accomplish these goals can help assure the long term survival of bighorn sheep in the CRB.

Suggested correlates:
Acres covered by federal/state cooperative bighorn management agreements
Acres of occupied habitat suitable for improvement
Bighorn population goals
Acres of vacant habitat suitable for re-introductions
Acres of non-suitable habitat that can be improved
Bighorn populations suitable as transplant sources

5) HABITAT MODELS

The majority of research in developing habitat evaluation procedures (HEP) and HEP models have been directed toward desert sheep Q. c. nelsoni Hansen 1980, Holl 1982, Armentrout and Brigham 1988). Only recently have efforts been made to design HEP models specifically for Rocky Mountain or California bighoms (Smith et al. 1991, Bleich et al. 1992) that incorporate evaluations of habitats to support minimum viable populations (MVP). Recommended MVPs for bighoms range from 100 to 150 (Geist 1975, Berger 1990 and Fitzsimmons and Buskirk 1992). HEP models when combined with population models that use population parameter estimates derived from aerial surveys corrected for visibility bias, can provide a powerful tool in predicting an area's suitability to maintain MVPs of bighorns (Smith et al. 1991, Bodie et al. 1995). A cooperative effort between land managers (HEP models) and wildlife management agencies (population models) is needed to enhance habitat and population management, and to improve the success of re-introduction programs (Schwartz et al. 1986).

Habitat, dry mountain grasslands interspersed with rocky escape cover.

Suggested correlates:
Existing habitat models
Topographic features including slope and aspect
Bighorn escape terrain, rocky cliffs
Vegetative parameters, no timber, no high brush
Human activity centers
Bighorn population parameters
Climax grassland
Snow depth

Additional references of interest:
Williams et al. 1977
Golden and Tsukamoto 1980
Grunigan 1980
Hansen 1980
Kling 1980
Risenhoover et al. 1980
Van Dyke et al. 1983
Armentrout et al. 1988
Grubb 1988

6) SUMMARY

Bighorn sheep in the CRB provide a wide range of social, economic, ecological, and cultural values. Faced with near extinction during the early part of this century, bighorn populations have been substantially increased through cooperative management efforts that included restrictive harvests, habitat improvement, and re-introductions of bighoms to vacant habitats. Many private groups such as the Foundation for North American Wild Sheep and the Boone and Crockett Club as well as individual hunters and non-hunters, have contributed large amounts of time and money to bighorn management efforts.

The bighorn is a high profile animal. The general public has been highly supportive of efforts to improve bighorn habitat, increase populations, and give priority to bighoms'in land management decisions. In some cases, bighorn re-introductions have been opposed by livestock and farming interests concerned that livestock grazing would be curtailed or eliminated if conflicts with bighoms occurred. Trophy hunting for mature 'rams has been the primary consumptive use of bighoms, although, several states are currently, experimenting with ewe hunts as a population regulation strategy. Harvest rates in the CRB are generally very conservative. Recently, non-consumptive uses have increased dramatically. In some areas, viewing bighoms has had a positive economic impact on areas surrounding bighorn habitat. The bighorn along with the wolf, and grizzly bear occupy a special place in the culture of Native Americans as well as a symbol of wilderness to the general public.

Although bighorn populations have increased during the past 30 years, we are still in a rebuilding process from the low population levels experienced in 1900. Continued and improved cooperative efforts between management agencies have the potential to double or triple existing populations in the CRB.

Extractive and recreation uses can conflict with bighorn management goals but the conflicts are not as severe or widespread as are conflicts with other species. Generally, bighoms use habitats that are of less value for extractive uses than species such as elk, although on a site specific basis severe real or perceived conflicts can and have occurred. Domestic sheep gazing, mining, recreation management, and military training areas have created substantial public conflicts on site specific areas.

Since most occupied and vacant bighorn habitat exists on lands managed by federal agencies, the future of bighorn sheep within the CRB will largely be determined by the land use decisions made by these agencies.

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1) PREAMBLE FOR UNGULATE ASSESSMENT: MOUNTAIN GOATS IN THE CRB

The mountain goat (Oreamnos americanus) is found only in northwestern North America. Although four subspecies (Oreamnos americanus americanus, Oreamnos americanus columbiae, Oreamnos americanus kennedy, and Oreamnos americanus missoulae) were recognized at one time, Cowan and McCrory (1970) found no valid reasons for recognizing subspecies within Oreamnos americanus. Most mountain goats in the lower 48 states are found in the Columbia River Basin Assessment Area. The mountain goat is not a true goat but an alpine antelope.

Ancestors of our mountain goat undoubtedly evolved in Asia and colonized North America via the Bering Land Bridge about 2.5 million years ago. No fossil evidence, however, of mountain goats have been found in Europe or Asia. The closest relatives are the Chamois (Rupricapra rupricapra) of Europe, the goral (Naemorhedus SD,), takin (Budorcus taxicolor) and serow (Capicomus sp.) of Asia.

Mountain goats were historically found in the mountainous areas of Northwest North America from southeastern Alaska to southcentral Washington. In the Rocky Mountains, mountain goats ranged from Alberta, Yukon, and British Columbia to Idaho and western Montana. Population size is difficult to quantify but state and provincial (Johnson, 1977) reports indicate historic population size at nearly 150,000 goats. Transplant programs initiated as early as 1920 have expanded goat distribution especially in central Montana, Oregon, Idaho, Utah, Colorado, Wyoming, and South Dakota. Mountain goats are unique ungulates in this regard for having enhanced distribution since colonization by European man. While goat introductions in these states have enhanced their distribution, total population size has decreased nearly half of historic levels.

In the Columbia River Basin area all mountain goat hunting is limited by permit draw. In Washington, there are 12 to 15 applicants for every goat hunting permit. The mountain goat is equally valued by nonconsumptive users. Many hikers and other appreciative users go to the back country to see and photograph these magnificent animals.

Throughout North America, mountain goats adapted to extensive differences in elevation and precipitation. In some areas, goats spend most of their summer above tree line but in other areas their mountain habitats do not reach above tree line. Mountain goats are closely associated with topographic features that limit their distribution. Most goat populations occur in small groups (30-50 animals) and are limited to specific mountains or mountain complexes. In general, mountain goats are not known for colonizing new habitats. Characteristic mountain goat winter ranges are steep rocky sites with slopes of 40 degrees or more close to diverse forage and cover. The best sites usually do not accumulate more than two feet of snow.

These features have made mountain goat habitat less affected by human development than most other big game animals. In the last few year this has changed as a variety of emerging public uses are posing conflicts with managing mountain goat habitat. Commodity extractions from public lands such as mining, and geothermal development could have an impact on goat populations. Other natural resource management programs like timber management, roading and grazing could impact goat management. Recreational development including helicopter skiing in some of the alpine habitats have the potential to negatively impact mountain goat abundance. This document will focus on primary issues and key correlates to identify and understand mountain goat habitat within the landscape assessment of the Columbia River Basin.

2) DEFINITIONS: ISSUES AND CORRELATES

ISSUE is any consideration usually created or controlled by man that has 1) a direct influence on mountain goats, or 2) on the distribution of goats, or on the environmental correlates that influence the fitness of mountain goats.

Primary issues are those elements of species or habitat management that can specifically define and control population numbers or habitat over time. In virtually all cases, primary issues will emerge from the careful analysis of site-specific opportunities, problems or concerns. Primary issues constitute the basic, relevant parameters that can be used on a landscape basis to understand the species and habitat relationships. They are generally biological in nature and can'be quantified, observed, and modelled.

Related issues are those that bring context and site specific resolution to mountain goat and goat habitat situations. They are often social in nature and influence the primary biological elements either positively or negatively. Related issues are frequently the starting point in mountain goat'management considerations, but generally must be reduced to primary issues in order to identify implementable actions.

Correlates are any factor that affects the distribution, abundance, and fitness of a species. In the context of application to CRB, correlates are of two types:

- Those that identify spacial relationships of issues, especially of primary, issues.
- Those that identify environmental features of species habitats.

Correlates should be detectable as a surface feature on the GIS coverages available for CRB analysis. Habitat correlates often answer questions about the niche filled by the species, or the evolutionary function served. They should identify landscape suitability characters and species limitations related to terrain and weather.

3) LIST OF ISSUES AND CORRELATES

PRIMARY: Road Access
Vegetation Management
Security
Winter Range
Fire Management
Harvest Management
Predator Prey relationships

RELATED: Recreation/Recreation Development
Competition With Other Herbivores

4) BRIEF, OBJECTIVE STATEMENT ABOUT EACH ISSUE

PRIMARY

ROADS/ACCESS

Forest roads are the primary mode of access to mountain goat habitat. As timber harvest has moved up the mountain slopes, more and more roads have penetrated mountain goat habitat. Most roads are built for timber harvest so the two activities are frequently interrelated. Road building and logging are temporary disturbances but access provided by open roads is a lasting source of disturbance. Chadwick (1973) found that goats in Montana continued to use cliff areas during initial road building and logging. Later, however, frequent blasting and increased activity caused goats to emigrate about three miles from the disturbance. The major factor in disturbance seems to be proximity of roads to preferred winter ranges. Roads adjacent to critical escape terrain are very important but roads through dense conifer forest seem to have little impact.

Winter recreation activities can also be a source of disturbance. In some areas, snowmobile or cross country skiers are a source of disturbance in critical winter habitat. In other areas, favorite rock climbing areas result in heavy use on weekends.

Another major disturbance in mountain goat habitat results from mining operations. In British Columbia, mountain goat declines have been closely correlated with coal and gas developments. These declines appear to be related more to roads and access than to actual disturbance to habitat.

SUGGESTED CORRELATES

Road density near escape terrain.
Open road density in winter.

SELECTED REFERENCES

Chadwick (1973)
Johnson (1983)
Pendergast and Bindernagel(l977)

PRIMARY

VEGETATION MANAGEMENT

Vegetation found in goat habitat in the Columbia River Basin is extremely diverse. Mountain goats in the xeric Pahsimeroi of Idaho utilize in curl leaf mountain mahogany while in western Washington goats thrive in mesic habitats adjacent to the rain forest. These extremes point out the ability of mountain goats to utilize vegetation that grows in a variety of habitats. While some plant species are far more nutritious than others, the goats do not seem to be dependent on a particular species unless the goat range is limited to certain forage species. Typically, vertical migration of goats take them through a variety of vegetation zones. In addition, natural events such as avalanches and wildfires create even more diversity in plant species composition.

Timber harvest influences mountain goats in a couple of ways. The most nutritious mountain goat forage is found in openings and timber harvest creates openings to promote that forage. Extensive clearcuts tend to be detrimental to mountain goats by creating areas avoided by mountain goats. In addition, roads associated with timber harvest may be a source of disturbance and contribute to hunting mortality.

Mountain goats are closely associated with rocky, cliff type habitat. Potential forage productivity is primarily a function of metabolizable energy in this terrain.

SUGGESTED CORRELATES

Cover/forage ratios.
Road density.
Proximity to escape terrain.

SELECTED REFERENCES

Johnson (1983)
Wigal and Coggins (1982)

PRIMARY

SECURITY

Mountain goats are more closely associated with rock or cliff habitat than any other ungulate. They are the most adept cliff dwellers of all bovids and depend on this terrain to escape from predators. The most important predators in the Columbia Basin are cougar, bears, golden eagles, coyote, and bobcat. Mountain goats remain in or adjacent to escape terrain most of the time but occasionally wander half mile or more to foraging areas. Billies tend to wander farther from escape terrain and nannies with kids are most dependent on cliffs for security. During late spring when kids are born, nannies with kids occupy the most precipitous terrain on their range.

When goats are in escape terrain they tend to ignore human intrusion into adjacent terrain. This trait makes them more vulnerable to hunter harvest.

SUGGESTED CORRELATES

Proximity to escape terrain.
Road density.

SELECTED REFERENCES

Anderson (1940)
Geist (1971)
Johnson (1983)
Shoen (1979)
Taber and Stevens (1980)

PRIMARY

WINTER RANGE

Characteristic mountain goat winter ranges are steep rocky sites with slopes of 40 degrees or more close to diverse forage and cover. The key environmental correlates are rugged terrain, steep rocky cliffs, rimrock, caves, and avalanche chutes. The best sites do not usually accumulate more than half meter (two feet) of snow because of steep slopes or low elevation. The elevation of winter ranges in the Columbia Basin is quite variable depending on local snow accumulation and topography. Mountain goats may seek the thermal cover of conifer stands or caves during inclement weather but other goats winter on open habitats.

The quality and size of winter ranges usually determines population potential. Winter severity may play a major factor in population dynamics. A long cold winter with above normal snow accumulation may result in high mortality, especially young of the year.

SUGGESTED CORRELATES

Juxtaposition of winter range.
Rock / cliff habitat.

SELECTED REFERENCES

Johnson, Wayne (1987)
Olmstead and Johnson (1979)
Schoen, J.W. (1979)

PRIMARY

FIRE MANAGEMENT

Wildfires area natural phenomenon that have occurred periodically throughout most goat range in the Columbia Basin. The impact of fire depends on habitat type. Mountain goat range in the Rockies is characterized by alpine habitat above tree line. Mountain goat habitat in the Cascades, however, has few alpine communities. Wildfires have been a frequent occurrence in forests dating back into prehistory. Mountain goats obviously evolved with periodic fires and seem to have benefited from their occurrence.

Fires release minerals and ash from burned organic matter and these are quickly utilized by herbaceous plants and resprouting shrubs are more nutritious and productive. In addition, elimination of tall plants allow new growth to be more available as forage than prefire plants.

Research in Idaho revealed fires in the 1930's were responsible for increased production of shrubs and prevention of forest encroachment. Lack of periodic fires results in conifer dominated habitats and changes in forage availability. Forage beneath conifer understory is less nutritious than found in open areas.

In summary, fires cause substantial diversity in plant communities and this diversity is beneficial to mountain goat forage. Five suppression has resulted in range deterioration and loss of quality habitat. In the Columbia Basin, effective fire control may be a key factor in mountain goat population declines. There has been much discussion of a let burn policy under certain conditions but implementation has been difficult to achieve.

SUGGESTED CORRELATES

Let burn policy.
Prescribed bums.

SELECTED REFERENCES

Brandborg (1955)
Douglas and Ballard (1971)
Johnson (1983)
Lyon and Pengelly (1970)
Olmstead (1979)

PRIMARY

HARVEST MANAGEMENT

Mountain goat hunting in the Columbia River Basin has become very limited and restricted to permit only hunting. Hunting is authorized only in Washington, Idaho, Montana, Nevada, and Colorado. Some states have a harvest goal of only four percent of the population each year. There seems to be a general decline in mountain goat abundance in the Columbia Basin but specific reasons are unknown.

Wildlife managers have expressed a concern with accessibility, harassment, and habitat destruction as a result of a spreading network of roads associated with logging and mining. Accessibility has been a problem in many areas because new roads in goat habitat concentrates goat hunting, leading to overharvest in localized areas. Fire suppression in goat range has also been implicated in habitat deterioration and a reduction in carrying capacity.

SELECTED REFERENCES

Johnson, R. (1977)
Kuck, L. (1977)

PRIMARY

PREDATOR/PREY RELATIONSHIPS

Traditional predator hunting programs are changing as society seeks to protect these species. Recent initiatives in California, Colorado, and Oregon will increase predator abundance.

Historically, most game managers have expressed little concern over predator take of mountain goats but this may be changing. The mountain lion (cougar) is probably the most serious predator of mountain goats and is a very efficient hunter. Incidents of cougar predation on mountain goats have been reported by Cowan (1944), Young and Goldman (1946), Cowan and Brink (1949), Hornocker (1970), and Johnson (1983). Brandberg (1955) speculated that mountain lions could make serious depredations on small isolated bands of goats. Considering their population increases in recent years and their hunting 'technique the mountain lion could be a significant mortality factor for mountain goat.

The other predators of mountain goats are golden and bald eagles, black bear, bobcat, lynx, and coyotes. Predation by these species is not considered a serious threat to mountain goat abundance.

SELECTED REFERENCES

Cowan (1944)
Cowan and Brink (1949)
Hornocker (1970)
Johnson (1983)
Young and Goldman (1946)

RELATED

COMPETITION WITH OTHER HERBIVORES

Mountain goats occupy a niche rarely preferred by other ungulates, particularly on critical winter ranges. Competition can occur when interspecies aggression causes one species to abandon a range, as well as when both species compete for the same forage.

Mountain goats and mountain sheep occupy similar habitats with goats preferring the more rocky/cliff habitat and bighorns preferring the vegetation found adjacent to escape terrain. In many cases the type of habitat found in overlapping ranges will determine if competition is a factor.

Clearcut logging is spreading up the mountains in the Cascades and elk are taking advantage of favorable forage in these areas. Research studies in Montana (Chadwick 1973) indicated goats could be dominated by elk if their ranges overlapped. For this reason forest management programs should consider the possible ingress of elk into mountain goat range.

Other ungulates including deer and cattle are not considered serious competitors because they occupy different habitats and have different forage preferences.

SELECTED REFERENCES

Campbell and Johnson (1983)
Chadwick (1973)
Klein (1983)

RELATED

RECREATION AND RECREATION DEVELOPMENT

While most wildlife species have suffered from loss of habitat as a result of human recreation activities, mountain goats occupy some of the more inaccessible areas and affects have only recently been realized. A limited number of summer cabins are being built in mountain goat habitat. As a result of logging activity there is an expanding network of roads into the mountains. This has led to more contacts from hunters, fishers, hikers, and mountain climbers. In addition, the popularity of helicopter skiing and destination ski resorts are a source of concern. Where these activities occur in goat range, potential adverse impacts from harassment are anticipated.

SUGGESTED CORRELATES

Subdivision/summer cabins.
Destination ski resorts.

SELECTED REFERENCES

Johnson (1983)

5) HABITAT MODELS

HABITAT MODELS FOR MOUNTAIN GOATS

A variety of habitat models have been designed for elk and deer but few for mountain goats. In goat management, the objective is to provide food, water, and cover in and adjacent to mountain goat habitat. One of the major influences on mountain goat habitat is human disturbance, especially on winter ranges. A mountain goat habitat model was developed on the Randle Ranger District of the Gifford Pinchot National Forest in Washington. This model includes the following:

Primary factors in this model included cover, optimal thermal cover, forage, and roads. A minimum of 75 percent of winter range should be in cover, with a minimum of 50 percent of the timber producing levels providing optimal thermal cover. Optimal thermal cover will occur contiguous to all natural avalanche chutes, talus slopes, and to cliffs (>10 feet high) for a minimum distance of 1,500 feet.

No more than 25 percent of the winter range should be in the forage classification. This includes man-made openings. All roads in mountain goat winter range would be closed and no new roads constructed. The reader is encouraged to contact Gifford Pinchot National Forest for specifics of the mountain goat habitat model.

Mountain goats are closely associated with topographic features that limit their distribution. Most goat populations occur in small groups (30-50 animals) and are limited to specific mountains or mountain complexes. In general, mountain goats are not known for colonizing new habitats.

Characteristic mountain goat winter ranges are steep rocky sites with slopes of 40 degrees or more close to diverse forage and cover. The best sites usually do not accumulate more than two feet of snow.

SELECTED REFERENCES

Fox (1083)
Johnson, Wayne (1987)
Kuck (1977)
Schoen (1982)

6) SUMMARY

Most mountain goat habitat in the lower 48 states is in the Columbia River Basin. Within the CRB, mountain goat abundance is declining. Reasons for the declines are likely related to a number of factors related to habitat and recreation. Most goat ranges are on National Forest lands but some of the winter ranges are managed by private landowners.

Biologically, mountain goats have not received the same level of attention as other wild ungulates. Research studies indicate a number of factors may be having a long range impact on goat population abundance. Roads and access to mountain goat habitat have negatively impacted goats primarily because of disturbance and hunter harvest. Timber harvest may have a negative or positive influence on goat habitat depending on size and proximity of habitat to escape terrain. Protection of mountain goat escape terrain is critical to goat abundance. Mountain’goat habitat is closely associated with physiographic features and mortality can be exacerbated by severe winter weather. Fire suppression in mountain goat habitat has had a negative impact on goat abundance. The benefits of periodic fire is well known and prescribed fire or let burn policies are needed to restore these habitats. Mountain goat hunter take is very limited and strictly controlled in each state by limited permit.

The related issues of recreation and recreation development, as well as competition with other herbivores are reviewed. In the future, the predator/prey relationships will have a greater influence on mountain goat abundance’as society votes to curtail hunting of selected predators.

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1) PREAMBLE FOR UNGULATE ASSESSMENT: PRONGHORN IN THE CRB

Pronghorn evolved on the prairies and desert of North America during the last 20 million years (Frick 1937), and are endemic to North America (O'Gara 1978). During recent pristine times, these animals ranged from the southcentral prairies of Canada through the western grasslands and shrub-steppe plains of the United States, south to the deserts and plateaus of northern Mexico. Today, suitable habitat has been greatly restricted, possibly more than 75%. Nelson (1925) estimated original numbers not less than 30-40 million. Areas of highest density were the short grass prairies where vast pronghorn and buffalo herds were legendary (Yoakum 1978). Reports from the journal of the Lewis and Clark expedition (Thwaites 1905) indicated pronghorn were most abundant on the Great Plains, where expedition members killed 62 for food; they only killed 3 west of the Continental Divide.

During settlement of the West, pronghorn numbers declined more than 99% (Yoakum 1968) because of fencing, habitat loss, competition with livestock, and. year-round hunting. About 1920, conservation-minded organizations supported state, provincial, and federal programs that controlled excessive hunting and provided protection through refuges. A prolonged drought, extending from 1918 to 1934 (Pechanec et al. 1937), together with low prices and surpluses of farm products, made cultivated crops uneconomical on semiarid homesteads. Marginal agricultural enterprises were abandoned and much of the cultivated land reverted to native vegetation. On some areas, however, vegetation damage by drought and heavy livestock grazing was so great that pronghorn were not able to survive (Nielson 1962).

The successful re-establishment of pronghom produced an increase from an estimated 30,500 in 1924 to more than a million in 1983 (Yoakum 1986). During this period, a legal harvest of more than 3.5 million pronghom was realized, making them valuable to local people and providing funds for management of the species (Morrison and O'Gara in prep.) . However, agricultural, urban, and mining expansion onto historic rangelands; fencing across routes of seasonal movements and removal of native vegetation by rangeland rehabilitation projects and heavy livestock grazing are obstacles to further population increases, possibly even to maintaining populations of this unique species in certain localities.

Fossil remains indicate that pronghom belong to one of the oldest artyodactyl families in North America, and it occurs nowhere else on the globe. It is the only living species of its genus, and that genus is the only living genus of its family. The pronghom is the only native ungulate truly at home on the open plains of the Columbia Basin, and it provides the only opportunity for most Americans to see, photograph, or hunt big game in such a setting.

2) Definitions

3) List of issues

PRIMARY:
1) Fences on rangelands occupied by pronghorn.
2) Livestock grazing on rangelands shared with pronghorn.
3) Predation on pronghom and additional food for carnivores.

RELATED:
4) Improving degraded rangelands for pronghom.

PRIMARY ISSUE: Fences on rangelands occupied by pronghom.

Fences seem to be the single most important factor limiting pronghorn numbers on the Great Plains. In the Columbia River Basin, fences may or may not be that important. Generally, fences on public lands have been modified to facilitate pronghorn movements. However, about 60% of all pronghom in Canada and the United States are on private lands (O'Gara and Morrison in prep.). For Columbia River Basin states, estimates of the percentages on private lands are as follows: Idaho, 25; Oregon ,15; and Wyoming 60. Pronghorn move a great deal to take advantage of the best range conditions and avoid deep snow. Even small amounts of private lands (or roads or railroads) with impassable fences can cause extensive mortality during severe winters or droughts. As human populations increase, private land will be used more intensively. Maintaining travel corridors through private land may be the only way to maintain pronghom on some public land.

Fences often have been barriers to movements of pronghom and have obstructed seasonal movements and travel to water and feeding areas. As a result, pronghorn populations have declined substantially on some of those rangelands. Extensive mortality has occurred in some areas when animals became entangled or trapped as they attempted to negotiate these barriers (Oakley 1973).

United States Bureau of Land Management (1985) manual H-1741-1 states that all means of livestock control (herding, use of natural land form to limit movement, exclusion of certain kinds and types of livestock, use of salt and water sources, etc.) should be considered before deciding to use a specific technique. The manual also directs that cost and potential effects of fencing require that its use be considered carefully, and consideration of all affected resource values is necessary before deciding to use fencing. Wyoming Game and Fish Department fencing guidelines maintain that no fencing should occur perpendicular to major migration routes or on transitional and winter rangelands of pronghom.

Often, past efforts were concerned only with searching for ways to modify pronghorn behavior to minimize the effect of fences. It cannot be assumed that pronghorn will adapt to changes in habitat resulting from livestock use or that they will learn behavior patterns that will permit them to thrive where their physical environment has been altered by fences. Observations in Wyoming indicate no marked increase in the number of pronghorn learning to jump fences, older individuals having a greater tendency to jump fences, and no fawns have been observed jumping fences (H. Harju, pers. comm.).

The problems of pronghorn negotiating fences have been noted for more than 100 years (Caton 1877). Pronghom most often go under, occasionally pass through, and rarely jump over fences according'to Einarsen (1948). Pronghom evolved in open, generally flat or undulating plains with limited tall vegetation. Their survival requirements did not include the necessity of jumping over obstacles.

Fences constructed to control domestic sheep were disastrous for pronghorn seeking preferred forage in the arid southwest (Buechner 1950, Hailey 1979). In northern habitats, fences impeded pronghom movements most during winters (Spillet et al. 1967, Oakley and Riddle 1974, Mitchell 1980, Barrett 1982, Pyrah 1987). Woven wire and sheep-tight fences prevent pronghorn from reaching rangelands with preferred forage or less snow. By restricting free movements, fences cause pronghorn to remain in areas offering little protection or food during storms, resulting in malnutrition and winter kills. Crusted or wind-packed snow covering the lower wires of a fence render it impassable by pronghorn because the possibility of crawling under is eliminated, and the snow does not provide a solid enough surface for launching an effort to jump. In this situation, fences should be “laid down” on pronghom movement corridors and wintering areas.

Two lawsuits have involved livestock fences and pronghom welfare on public lands. On the Roswell Grazing District in New Mexico, fences were modified to permit pronghorn passage. The decision to modify the fences on public land was contested. The appeal was dismissed in administrative hearing, resulting in a victory for pronghorn and multiple use on public lands. It appears modifying fences is on solid legal ground (Yoakum 1980).

The second legal case established an important precedent. A rancher near Rawlins, Wyoming constructed a fence around approximately 3,885 ha of private and public lands, thereby excluding pronghom from use of critical winter rangelands. Many pronghom died due to fences restricting access to favored winter foraging areas. The case went to the United Stated District Court for the District of Wyoming and the judge decreed that the woven-and-barbed wire fence was in violation of the federal Unlawful Inclosures Act of 1885. Immediately, the rancher appealed the federal judge’s ruling and the case went to the Tenth Circuit Court of Appeals, and 3 judges unanimously upheld the lower court’s decision.

Specifications for fences that allow passage of pronghorn can be found in O'Gara and Yoakum (1992).

CORRELATES:
Livestock grazing allotments

PRIMARY ISSUE: Livestock grazing on rangelands shared with pronghom.

Livestock grazing has reduced grasses and forbs in many of the drier areas of the Columbia River Basin (Personal observations in Idaho and Oregon). As that happens, livestock concentrates in riparian areas and on the few mesic meadows that exist--exactly the areas needed by pronghorn does to raise fawns during a dry year.

Rangelands can be altered rapidly by livestock (Wagner 1978, Kindschy et al. 1982, Wald and Alberswerth 1989). These changes can affect both the quality and quantity of preferred forage needed to sustain thrifty pronghom herds (Ellis 1970, Howard et al. 1990). Decreasing vegetative cover through livestock grazing was reported by Autenrieth (1982) as a serious factor affecting fawn survival in Idaho. Heavy use of forage by livestock during a severe drought forced pronghom to turn to poisonous plants, resulting in direct mortality and subsequent reproductive losses (Hailey 1979).

McNay and O'Gara (1982) reported displacement of parturient does in Nevada by livestock. does used traditional fawning areas when livestock were not present, but moved to adjacent sites when livestock were allowed on fawning areas. Such competition for space resulted in does moving to sites with less desirable vegetative height. Management guides to alleviate this problem include delayed turn-out of livestock until after the pronghorn parturition period, or the herding of stock from traditional fawning areas.

At times, livestock and pronghom have commensal relationships. Rangelands with an abundance of grasses, especially on the Great Plains, can be heavily grazed by livestock, causing increased production of forbs and shrubs preferred by pronghorn. Then too, pronghorn consume many plant known to be noxious or poisonous to livestock such as larkspur (Delphinium sp.), death camas (Zygadenus spp.), and halogeton (Halogeton spp.; Yoakum and O'gara 1990). Predator control programs for livestock sometimes provide benefits to pronghorn. Connolly (1978) lists numerous cases of predator control increasing pronghom populations, several of them in the Columbia River Basin.

Forage competition between domestic sheep and pronghom, due primarily to both species consuming large quantities of forbs and shrubs, was found in six food habit studies evaluated by Yoakum and O'Gara (1990). Sheep trailing through pronghorn fawning areas during the fawning season may interrupt fawn imprinting and render some does incapable of finding their fawns. Diet overlap between pronghorn and cattle or horses on grasslands in good ecological condition seems minimal.

The impact of livestock grazing on pronghom in the Columbia River Basin has received little attention. However, studies in the Great Basin no doubt have application there.

For management purposes, pronghom populations fall into two groups. Harvest strategies and habitat management must be vastly different for the two. Buechner (1961) maintained that types of population control placed pronghom into two groups: (1) Those in which numbers were regulated by man in the region of dry-land agriculture and Short Grass plains east of the Rocky Mountains and (2) those in which numbers were regulated by natural phenomena in the more arid grazing lands of desert shrub and desert grassland on intermontane flats, high plateaus, and rolling plains in and near the Rocky Mountains.

At the time Buechner (1961) wrote the above, he estimated about 400,000 pronghorn on the western plains. That number more than doubled during the following 30 years, and human regulations of numbers became more common in Group 2. Yet, the differences are obvious; as Buechner pointed out, states in Group 1 (mostly eastern Short Grass vegetation) harvest 17-33% of their midsummer populations annually; the states in Group 2 (Western Desert Shrub and Desert Grassland vegetation) harvest 2-10% of their populations. Buechner also cited counts of fawns per 100 females during mid-summer as 78-113 in Group 1 and 40-85 in Group 2 .

In part, the low numbers of fawns per 100 does in Group 2 reflect the influence of recurring droughts on desert vegetation that has been abused for decades by overgrazing with livestock (Buechner 1961). Leopold (1949:206) also believed livestock had degraded southwestern vegetation; he wrote. “The impact of occupancy here brought no bluegrass, or other plant fitted to withstand the bumps and buffetings of hard use. This region, when grazed by livestock, reverted through a series of more and more worthless grasses, shrubs, and weeds to a condition of unstable equilibrium. Each recession of plant types bred erosion; each increment to erosion bred a further recession of plants. The result today is a progressive and mutual deterioration, not only of plants and soils, but of the animal community subsisting thereon.”

Ellis (1970) compared population dynamics and habitat characteristics for pronghorn herds in the Great Plains with those of herds in the Great Basin, concentrating on the last 2 months of gestation and the first 2 months of lactation. Ellis concluded that fawn survival was twice as high on the Great Plains because of abundant nutritious grasses and forbs during late gestation and early lactation. Thus, the low availability of these forage classes, mainly because of consumption by livestock, resulted in rangelands of low carrying capacity for pronghom in the Great Basin.

Maternal condition late in gestation can affect birthweight in ungulates (Thome et al. 1976). Low birthweight may increase susceptibility of offspring to hypothermia or starvation (Clutton-Brock et al. 1982, Thome et al. 1976), or increase vulnerability to predation. Birthweight can be a factor in survival to weaning in some years (Fairbanks 1993). This is especially true because does that produce underweight fawns generally are in poor condition to provide adequate milk.

Realization of how livestock impacts vegetation in arid areas has led to some recent changes in management practices. From 1936 to 1990, livestock were used to enhance pronghorn habitat on the Hart Mountain National Antelope Refuge in Oregon (Pyle and Yoakum 1994). From 1989 to 1994, resource inventories and management strategies were re-assessed and a comprehensive management plan/environmental impact statement was developed (U.S. Fish and Wildlife Service 1994a). As a consequence, management practices for pronghorn and their habitat on the Refuge were extensively modified. The new management program eliminates livestock grazing for 15 years and establishes prescribed burning as the primary practice to restore pronghorn habitat to its ecological potential (U.S. Fish and Wildlife Service 1994b).

Reduced livestock grazing undoubtedly would benefit pronghom in much of the Group 2 habitat, including the Columbia River Basin.

CORRELATES:
Livestock grazing allotments
Spring range

PRIMARY ISSUE: Predation on pronghom and additional food for carnivores.

Predation undoubtedly is a limiting factor on pronghom numbers in the Columbia River Basin. Pronghorn also contribute to stable populations of most of the large carnivores in the Basin.

Pronghorn seem more vulnerable to predation than do other North American artyodactyls. This is not a problem on the Great Plains where pronghom are numerous. In the intermountain west, where pronghorn are not numerous but predators are, predation often reduces pronghom reproduction to levels that barely sustain populations. This presents a problem if providing adult pronghom for hunters or expanding pronghom populations are management objectives. Where holistic wildlife management is an objective, pronghom can be considered an important food source for a variety of carnivores--especially coyotes, bobcats, golden eagles, and mountain lions.

Pronghorn, although they have made an impressive comeback, sometimes are restricted in their movements by agricultural areas, highways, and fences. Thus, some herds are localized and relatively small. Under such artificial circumstances, predators may keep pronghom populations from increasing or even eliminate them (Udy 1953). Control of predators to benefit a big game population often involves reduction of predators over a large area; even if desirable, such control seldom is economically feasible. However, Willis (1988) indicated that selective, time-specific application of aerial gunning in areas of high coyote density was an economically beneficial means of increasing numbers of pronghorn in Hamey County, Oregon.

As pointed out by Hornocker (1970), if suitable habitat is not available for a prey species, no amount of predator control will bring about flourishing populations of that prey species. Also, controlling one species of predator may be compensated for by increased predation by other species, as happened on the National Bison Range when coyotes were reduced and predation by bobcats and golden eagles increased (Corneli et al. 1984). The overriding influences on the degree of mortality are prey species' populations levels and the quantity and quality of habitat available to pronghom and how this habitat is providing cover, space, and nutrition.

Wherever pronghorn are static or declining, predation can trigger or accelerate a downward trend. Most pronghorn predators are not tied to rises and falls in pronghorn populations. They are generalists depending on a wide variety of large mammals, rodents, lagomorphs, birds, reptiles, invertebrates, and in the case of coyotes even vegetable matter. Thus, their effect as predator may increase when pronghorn populations are small or decreasing. Predators taking 100 fawns from a population in a valley where 1,000 fawns are born means little, but their taking 100 fawns where only 200 are born becomes significant.

Although predators cause substantial mortality in some populations, such mortality probably is compensatory in many instances, especially if adult mortality by hunting is low. Many conservationists, including some biologists, maintain that predators cull weak and sick animals to the benefit of the prey population. Under ordinary circumstances, young prey animals that end up in a predator's stomach are likely to be as healthy as the ones that get away, sickly fawns may even avoid predation because they move. less and draw less attention than do healthy ones (O'Gara et al. 1986).

Early studies concerning causes of low fawn survival could not account for most of the fawns that simply disappeared, but predation generally was dismissed as a significant factor.. Remains of fawn carcasses are relatively hard to find. Since the advent of miniaturized radio transmitters, determining the actual numbers of pronghom fawns killed by predators has been possible and the percentages killed in some areas are significant to the population. The first published biotelemetry study of predation on pronghorn fawns was by Beale and Smith (1973) in western Utah. Of 44 instrumented fawns recovered after death, 27 had been killed by bobcats. Bobcat predation was cited as the greatest single factor reducing the pronghorn population, although only a few bobcats were involved. Thirteen later studies involved 787 pronghom fawns for which fates were known. The morality for those instrumented fawns was 67%, with predation accounting for 79% of the total mortality. Mortality undoubtedly was higher than indicated because most radio transmitters were designed to fall off by the time the fawns were about 2 months of age. Beale's (1978) study showed that Utah fawns were still being killed by predators at 4 months of age.

Of the 13 fawn mortality studies, only 4 were conducted in Columbia River Basin states (Beale 1978 in Utah, Bodie 1979 in Idaho, Trainer et al. 1983 in Oregon, and Autenrieth 1984 in Idaho). During those studies, 440 pronghom fawns were radio collared. Of those, 208 (47%) were killed by predators; 101 by coyotes, 52 by bobcats, and 38 by golden eagles. The other 7 were killed by badgers, prairie falcons, or unknown predators.

CORRELATES:
Coyote populations
Golden eagle
Bobcat
Mountain lion

RELATED ISSUE: Improving degraded rangelands for pronghom.

Degraded rangelands may be improved for livestock. When that happens, restoring key forbs and shrubs and not grazing them beyond their sustainable tolerance will benefit pronghorn (Yoakum and O'Gara 1990).

Pronghorn thrive best on rangelands in a sub-climax vegetative condition. Such conditions were historically created by wildfires and seasonal grazing by herbivores such as bison and elk. On western rangelands today, most range improvements are for livestock needs. These projects can be beneficial or detrimental to pronghom. To benefit pronghorn, range improvements must provide habitat diversity. Low diversity stands of natural or artificial origin can be improved by adding species that provide food or cover, whichever is most limiting (Yoakum 1980, Yoakum et al. In prep.).

Many former grasslands in the intermountain west have suffered shrub encroachment because of livestock grazing. However, shrub control and artificial seedings that develop monocultures have limited value for pronghorn (Yoakum 1980, Kindschy et al. 1982), especially when accomplished in large blocks (2,000-6,000 ha). Large projects require pronghorn to travel long distances for preferred shrubs during plant succession.

5) HABITAT MODELS

Population models for pronghom commonly are used by state wildlife agencies, primarily for harvest regulation. However, I could find only 1 habitat model for the species (Allen et al. 1984). Kindschy et al. (1982) provided evaluation criteria and a worksheet for rating pronghorn habitat potential in the Great Basin.

Allen et al. (1984) indicated their model would be useful in the Columbia River Basin. Data must be gathered on pronghorn and pronghom habitat in the Basin for the model to be useful--especially on locations of winter and fawning areas and movement corridors. The Habitat Use Information Section is largely constrained to data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for this HSI model.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes that habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques.

In essence, the model is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. Feedback is encouraged by the authors because models that have demonstrated reliability in specific situations may prove unreliable in others.

Cook and Irwin (1985) evaluated the HSI model by Allen et al. (1984) using data from 29 pronghorn winter ranges in Colorado, Idaho, Montana and Wyoming. Cook and Irwin proposed that the model is applicable throughout the historic range of A. a. americana. Model ratings of habitat quality (independent variables) were correlated with estimates of winter pronghorn densities (dependent variable). Output of the original model was significantly correlated to pronghorn densities but several alterations substantially improved model performance. Model variables found to be most important were the suitability indices for canopy cover particularly and topographic diversity. Removing model variables found to be statistically insignificant was not recommended because the simplified version would likely be less robust across a wide variety of habitat conditions.

Irwin and Cook (1985), using data from the same 29 winter ranges, reported that their data weakly supported the inclusion of another model variable--shrub height--in the Allen et al. (1984) model. Their findings indicated that the HSI model is useful for winter pronghom habitat management and mitigation because relatively easily managed (or impacted) HSI variables were correlated with pronghom population characteristics.

What constitutes good fawning habitat is not too clear. In Idaho, Autenrieth (1984) indicated that hiding cover somewhat alleviated fawn predation. In Nevada, McNay (1980) assumed poor cover was a factor in the probability of coyotes locating bedded fawns. However, in another Idaho study, Bodie (1979) found that fawns bedding in tall sagebrush/foothill community vegetation suffered significantly higher predator-related mortality (1 per 10.6 days use) than did fawns using short sagebrush/brass community vegetation (1 per 101.5 days use). Aggressiveness of the does towards predators, whose approaches were easily seen in the short vegetation, may have contributed to the difference. Possibly other factors -- lookout points for bobcats and earles, denning sites for coyotes, or updrafts for soaring eagles -- may influence predation more than do vegetative cover.

There is more to a good winter range than just a certain size and density of shrubs. When R.L. Hoskinson was working on his Ph.D. thesis in Idaho during the mid 1970s, he found that pronghoms used certain stands of big sagebrush every winter, and did not use other stands that looked similar and had comparable snow depth. Laboratory tests showed that the soil and sagebrush leaves in the areas used by pronghom had higher calcium content than did those in areas that were not used.

CORRELATES:
Grass/forbs in the spring
Subclimax vegetation
Habitat parameters favoring pronghorn (see Appendix)

- low rolling, to flat terrain
- 20-38 cm precipitation
- snow depths under 30cm
- grass/forb rangelands, vegetation <45 cm
- open water sources

SUMMARY

Pronghorn evolved on the western plains of North America as a small ruminant dependent primarily on succulent forbs and shrubs for survival. As plains animals, their behavior does not include jumping obstacles, such as fences. Long seasonal movements often were made to reach the needed succulent foods. Movement routes blocked by human-made structures greatly reduced the carrying capacity of many areas for pronghom.

Pronghorn also require comparatively short vegetation, in which they can see predators and run from danger. They thrive on seral vegetation created by fires on grasslands or shrub-steppes. However, livestock grazing in the Columbia River Basin can decrease forbs available to pregnant and lactating pronghom does and lead to dense or high shrub communities unsuitable for pronghom. If pronghom are a high priority in management of such areas, controlled burns or shrub control by other methods, followed by seeding a mixture of grasses, forbs, and shrubs, usually increases populations.

Four studies in Columbia River Basin states have indicated a 47% predation rate for pronghom fawns. During early reintroduction attempts in Oregon and Washington, herds did not prosper until coyote control was begun. After control ceased in Washington, pronghorn were exterminated. Adult mortality has not been studied in the Basin, but adult mortality by mountain lions, golden eagles, bobcats, and coyotes occurs in other areas of somewhat similar habitat. these mortality factors must be kept in mind when managing pronghom in the Basin.

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APPENDIX: DESCRIPTIONS OF FAVORABLE HABITAT PARAMETERS

The following are habitat parameters favoring pronghom in grassland and shrub-steppe biomes (Yoakum 1972, 1974, 1980, in prep. a, Sundstrom et al. 1973). Similar criteria have not been developed for the desert biome.

1 .Abiotic

a. Physiography

Pronghorn typically use low rolling, expansive terrain. The area required depends on habitat quality and, in come areas, migration corridors to avoid deep snow. Differentiation of summer and winter rangelands usually is based on snow accumulation, distances between preferred seasonal foraging areas, and sources of drinking water.

b. Natural Barriers

Natural barriers affect movements and thereby the occupancy of habitats. Such natural barriers include large bodies of water, large rivers, abrupt escarpments or mountain ridges, thick high shrubs or trees, and deep canyons. Einarsen (1948) cited examples of such barriers when he referred to 2 cases (the Columbia River and a forested area) where pronghorn did not pioneer nearby, suitable habitat isolated by these barriers. However, in some areas of the Columbia River Basin--particularly in Oregon, some pronghom pass through forested areas between seasonal ranges.

c. Elevation

Pronghorn inhabit rangelands from sea level to 3,353 m. One herd occupies habitat at sea level in Mexico. Likewise, small herds use alpine meadows in Oregon and Wyoming. Greatest densities occur between 1,200 and 1,800 m above sea level.

d. Precipitation

Highest pronghom densities appear to be in habitats averaging 20-38 cm precipitation per year. Populations in precipitation belts above or below these parameters have lower survival rates and densities.

e. Snow

When snow depths exceed 25-30 cm, pronghorn frequently have difficulty obtaining forage. Prolonged seasons of deep snows are especially detrimental when combined with factors such as: low temperatures; alternate freezing and thawing; low quantities or qualities of forage; frequent wind (increasing chill factors) or complete absence of wind; resulting in no bare patches; and obstacles to movement, especially fences (Sundstrom 1969, Riddle and Oakley 1973, Hailey 1979).

f. Temperatures

Low temperatures seldom are a major limitation unless combined with deep, crusted snow. Pronghorn are adapted to hot deserts or alpine plateaus. Freezing temperatures and precipitation during fawning may cause mortality to newborn fawns (Hansen 1955, Yoakum, 1957, Kindschy et al. 1978).

2.Biotic

The following vegetative characteristics of habitats represent preferred pronghorn rangelands currently occupied.

a. Ground Cover

Ground cover averages 50% living vegetation and 50% bare ground, rock, litter, etc. for shrub-steppes; on grasslands, the averages are 60-80% vegetation and 20-40% non-vegetation.

b. Composition

Generally, composition of vegetation is 5-15% grasses, 5-10% forbs, and 10-35% shrubs on shrub-steppes; in grasslands, composition is 50-80% grasses, 10-20% forbs, and less than 5% shrubs.

c. Diversity

Within shrub-steppes, species often average 5-10 grasses, 10-70 forbs, and 5-10 shrubs; whereas, on grasslands the averages are 10-20 grasses, 20-60 forbs, and 5-10 shrubs.

d. Rangeland Types

Open rangelands supporting a variety of vegetative types (meadows, forb patches, riparian areas, etc.) are preferred in contrast to monotypic vegetative communities (Yoakum 1957). Pronghom use areas of recent wildfires for foraging. Such areas often provide grass sprouts and an abundance'of succulent forbs (Deming 1963, Courtney 1989).

e. Height

Low vegetative structure, averaging 25-45 cm is preferred. Vegetation over 60 cm is less preferred, and that taller than 75 cm is infrequently used. Pronghom may use areas of high shrubs while traveling to or from preferred rangelands. Reduced visibility or decreased mobility due to high vegetation is an important factor in pronghom survival (Goldsmith 1990).

3.Key Rangelands

Key rangelands are those areas necessary to sustain a population during the most limiting condition (e.g., severe winters, droughts). Use may or may not be seasonal, often depending upon environmental conditions. Key rangelands for pronghorn vary widely in relation to land management practices, geographic location, climate, soils, and habitat types. Key rangelands used by pronghorn may include: spring (Becker 1972) and winter areas (Compton 1970, McKenzie 1970, West 1970, Taylor 1975), seasonal movement routes, free water (Sundstrom 1968, Beale and Holmgren 1974), and fawning areas (Einarsen 1948, Pyrah 1974, Autenrieth 1976). These critical areas should be delineated on maps to identify needed habitat management practices for management plans.

4.Water

Measurements were made of water consumption by 25 to 35 pronghorn in a study pasture near Wamsutter, Wyoming (Sundstrom 1968). Daily consumption rates per adult pronghom varied from 0.34 1 per day in May to 4.50 1 per day in August. Total monthly precipitation, evaporation, succulent vegetation, and average maximum temperature had marked effects on the daily water consumption rates.

In Texas, droughts caused decreased pronghom vitality, resulting in decreased fertility (Hailey 1979). In Wyoming, Baker (1953) found that pronghom killed themselves trying to get through fences to reach water. Pronghorn will drink from most facilities designed for livestock, and those facilities should remain usable throughout the summer and fall on northern rangelands and year-round in southern habitats.

A close relationship was observed between pronghom distribution and water locations in Wyoming's Red Desert; 95% of 12,465 pronghorn counted from the air were within 6 km of a water source (Sundstrom 1968). Occasionally, adult males were farther from water. Benson (1956) considered the advent of water development in Saskatchewan to be associated with the spread of pronghorn there. In Oregon (Anonymous 1961), it was felt that adequate rangelands were available for many more pronghom, but places for them to drink in late summer were not. Beale and Smith (1970) suggested that water developments may encourage distribution of pronghorn where natural water sources are limited, particularly during dry seasons or drought years.

Water requirements of pronghorn have been reported variously over the years. Most authors associate high density populations with abundant water (Sundstrom 1968, Kindschy et al. 1978, Yoakum 1980). Some authors reported little or no use of water (Hoover et al. 1959, Phelps 1978). After evaluating various reports, Yoakum (in press a) stated that high density populations are associated with abundant drinking water, whereas pronghom exist at low densities in semi-arid regions and deserts with little available water.

APPENDIX 2: Guidelines for vegetation manipulation to improve rangelands for pronghom.

Areas dominated by shrubs are not desirable habitat because shrubs compete for moisture and nutrients with forbs, and thick or high vegetation prevents pronghorn from sighting and escaping enemies. Shrub control may or may not enhance pronghorn habitat, depending on local conditions and how the treatment is implemented. Numerous reports documented increased carrying capacity for pronghom in the Great Basin region through shrub control (Yoakum 1978, 1980, Kindschy et al. 1982). Areas of tall dominant shrubs (more than 50% of canopy cover) may be marginal or low density rangelands for pronghom. This is especially true where brush is 75 cm or higher (Willis et al. 1988). Such areas may be treated to decrease brush quantity and height. Limiting the size of projects to less than 400 ha blocks is recommended. Each project should maintain 5-20% browse canopy cover. Winter rangelands and spring fawning areas should be included in brush control projects only when shrubs are decadent. Shrub control projects should not attempt to eradicate shrubs because shrubs are preferred, nutritious forage during fall and winter. Shrubs are of utmost importance where snowfall exceeds 30 cm.

Shrub control frequently is accomplished by mechanical practices such as plowing and chaining. Plowing with large brushland plows can remove 90-95% of the shrubs (Vallentine 1989), but often kills forbs that are highly preferred by pronghorn. Chaining is accomplished by pulling a heavy anchor chain between 2 large tractors. This practice does not kill as many shrubs and is much less damaging to grasses and forbs.

Chemical spraying is another shrub control technique. The spray (usually 2-4-D) controls shrubs without harming native grasses and can be targeted to specific species of plants (Vallentine 1989). However, applications of improper chemicals or treatments at inappropriate times can result in high losses of forbs. To avoid killing forbs, late spring and summer spraying should not be considered.

Wildfires are natural on western rangelands and are considered one of nature's primary ways of developing and maintaining grasslands (Sauer 1950). Burning is the oldest known practice used by man to manipulate vegetation (Vallentine 1989). Prescribed burning can be beneficial and economical as a habitat improvement technique. Prescribed burning involves systematic planning so fires are set when weather and vegetation are in a condition to maximize benefits.

Prescribed burning can improve rangelands for pronghom. When properly accomplished, burning can decrease shrubs and not seriously harm grasses and forbs (Beardahl and Sylvester 1974). Investigators have reported immediate stimulation of plant growth resulting in greater forage yield. Forb production may be increased (Deming 1963, Yoakum 1980, Courtney 1989).

Vallentine (1989) provided a thorough discussion on objectives, techniques, and results of burning shrublands. Pechanec et al. (1954) recommend burning only: where sagebrush is dense and forms more than half the plant cover; where fire-resistant perennial grasses and forbs form more than 20% of the plant cover, or the area will be seeded after burning; when the economic and biological needs of all uses of the site (livestock forage, big game rangelands, watershed values, etc.) have been considered; during late summer or early fall; not earlier than 10 days after perennial grass seed is ripe and scattered, and after leaves are nearly dry.

Deming (1963) reported on the relationships of wildfire burns to pronghom in Oregon. He noted that after sage brush had burned, grasses and forbs remained greener and succulent 3-4 weeks later during spring. He also observed that pronghom moved into recently burned areas.

The recommendations of Plummer et al. (1968) for mixture seedings (10-30 species of grasses, forbs, and shrubs) are excellent. Seeded monocultures frequently have low densities and varieties of forbs. Many manipulated rangelands have been planted to exotic perennial graminoids seldom consumed by pronghom, such as crested wheatgrass (Agropyron sp.). Pronghorn prefer finer textured native grasses, such as Sandberg's bluegrass (Poa sandbergii). Although mixture seedings are more costly, they result in a greater diversity of species somewhat comparable to what existed prior to artificial seedings, Also, mixture seedings are in conformity with Federal laws (such as the National Environmental Protection Act of 1969, the Federal Land Policy and Management Act of 1976, and the Surface Mining Act of 1977), that mandate public lands be managed for their natural vegetation, including sagebrush (Artimesia spp.).

Ten principles for successful restoration of rangelands used by wildlife in Utah were developed for large-scale programs (Plummer et al. 1968). The procedures have wide application on similar sites throughout the west, although some modifications may be necessary to meet ecological conditions in local environments.

Changes in plant cover by the proposed measures must be desirable. Often lighter grazing by livestock, so that desirable species can grow, may be all that is required.

Terrain and soil types must be suited to the changes selected. The soil and terrain should be carefully considered to determine where appropriate treatment would produce the most forage for wildlife.

Precipitation must be adequate to ensure establishment and survival of seeded plants. The amount of precipitation, along with occurrence of indicator plants, is the most important guide to what may be seeded successfully.
Vegetal competition must be low enough to ensure that desired species can be established. Anchor chaining is a highly versatile, effective, economical, and a widely applicable method for eliminating competition of trees and shrubs.

Only species and strains of plants adapted to an area should be planted. Seeded species must be able to establish and maintain themselves. There should be a mixture of grasses, forbs, and shrubs.

Mixtures, rather than single species, should be planted. Seeding mixtures is advantageous when the major purpose of restoration is for the improvement of diversity needed by wildlife.

Sufficient seed of acceptable purity and viability should be planted to assure a stand. The amount per acre depends on seed purity, size, and viability and whether'seeds are drilled or broadcast.

Seeds must be covered sufficiently. Planting deeper than 13 mm is seldom desirable; likewise, leaving seed exposed is unsatisfactory.

Planting should be done in the season of optimum conditions for establishment. Whenever climate permits, seeding in winter (December - February in Utah) is best. Transplanting of nursery stock seedlings and wildlings is most successful when completed while the ground is still wet from spring moisture.

The planted area must be adequately protected. Young plants and seedlings should not be grazed or trampled by livestock or big game.

When properly accomplished, artificial seedings have proven to beneficial to pronghorn. An evaluation of the 11-year, large-scale restoration project near Vale, Oregon disclosed herd increases of nearly 100% near seeded areas, many with dryland alfalfa, compared to adjacent untreated lands where populations increased 30% (Kindschy et al. 1982). Pioneering pronghom herds in California, Oregon, and Nevada moved to manipulated rangeland areas producing an abundance of grasses, forbs, and shrubs meeting the pronghom's habitat requirements (Yoakum 1980).

1) Preamble
2) Definitions
3) List of issues
4) Brief statement about each issue
Correlates
References
5) Habitat models
6) Summary

UNGULATE ASSESSMENT: MOUNTAIN CARIBOU IN THE CRB

PREAMBLE

Caribou (Ranger tarandus), family Cervidae in the Order Atriocactyla, have existed for more than a million years and were once associated with the wool mammoth (-Mammuthus primigenius) (Banfield 1961, Bergerud 1978a).. "Caribou" is attributed to early French explorers of eastern North America who derived it from the Micmac Indian term "Xalibu", the pawer or shoveller (Banfield 1961). Several early taxonomic classifications have been made, but the most recent and widely accepted classification of Rangifer was by Banfield (1961) who listed 9 subspecies, 2 of which are extinct. The woodland caribou (R.t.. caribou) is restricted to North America and is further broken down into 2 "ecotypes": mountain and northern (Scott 1985), Stevenson and Hatler 1985). Ecotypic differentiation is based on habitat use and behavioral patterns and is not a genetic consideration. The mountain ecotype of woodland caribou is found in eastern British Columbia, and western Alberta South of Prince George, B.C. The Selkirk Mountains caribou ecosystem is within the range of the mountain ecotype.

Prior to 1900, woodland caribou were distributed throughout much of Canada, and the northwester, northcentral, and northwestern conterminous United States. Caribou are occasionally sighted in Minnesota (Mech 1982), but they disappeared from Maine, Vermont, New Hampshire, Michigan, and Wisconsin (Fashionbauer 1965, McCollough 1990). There was an unsuccessful attempt to reintroduce caribou to Maine in the 1980s (McCullough 1992).

The last confirmed report of a caribou in Montana occurred in 1958 (Manley 1986). Since then several unconfirmed sightings have been reported and tracks were documented in northwestern Montana in the mid-1980s (Manley 1986, USFS files). The Forest Service has listed caribou in Montana as a sensitive species.

Caribou in Idaho historically occurred as far south as the Salmon River (Evans 1960). Since the 1969s the last remaining woodland caribou population in the United States has restricted its range to the Selkirk Mountains of northeastern Washington, northern Idaho, and southeastern British Columbia. As recently as the 1959s, the Selkirk population consisted of over 100 animals (Flinn 1956, Evans 1960). However, by the early 1980s this population had dwindled to 25-30 individuals whose distribution. centered around Stagleap Provincial Park, British Columbia.

In 1980 the Selkirk Mountain population of caribou were petitioned for listing under the Endangered Species Act. The final rule was published in February, 1984. Listing the population under the Act means that all federal actions or activities that might affect caribou must be reviewed by the USFWS (USFWS 1994). Forest Service direction is to manage National Forest System habitats and activities for threatened and endangered species to achieve recovery objectives and to promote recovery efforts through Research and State and Private Forestry programs (USFS-FSM 1991).

Population augmentation was proposed as a way of increasing the existing population, and an augmentation plan and environmental assessment was prepared (Summerfield 1985) As a result of the augmentation plan, 60 additional caribou were transplanted into the Selkirks from central B.C. during the years of 1987-90.

The habitat use and movement patterns of the woodland caribou in the Selkirk Mountains have been studied in some depth since the early 1980s, and several studies on other populations have been completed. woodland caribou, in general do not make the long, mass migration for which tundra caribou (R.t. groenlandicus) are famous. However, seasonal movements and migrations are characteristic of many, but not all, woodland herds (Shoesmith and Storey 1978, Bloomfield 1980, Simpson et al. 1985, Antifeau 1978, Cichowski 1989, Servheen and Lyon 1989).

Generally, the Selkirk mountain population of woodland caribou exhibit five distinct seasonal movements:
In early winter caribou shift .to lower elevations habitats best characterized by mature to old-growth subalpine fir/Englemann spruce and western hemlock/western red cedar forest types and the ecotone between these on moderate slopes with a high density of recently windthrown arboreal lichen-bearing trees. These habitats occur generally between 4,000-6,000 feet elevation.

The movement from early winter to late winter. habitats occurs as snow accumulates and hardens, allowing easier movement and lifting the caribou into the lichen-bearing forest canopy. Later winter is characterized by deep snow and a snowcap capable of supporting a caribou. The Englemann spruce/subalpine fir forests used during this period are characterized by open canopies (10-50 %), generally above 6,000 feet.

In spring, caribou move to areas that are “greening up”. The Selkirk caribou remain at mid-elevation where they use open canopied areas or openings often adjacent or within mature forests.

Summer is spent in the alpine and subalpine vegetation zones with relatively open canopies providing an abundance of forbs and vaccinium. As summer progresses, caribou move to more closed-canopied forest stands. Summer range includes the western cedar/western hemlock and the Englemann spruce/subalpine fir zones at an average elevation of 5,600 feet.

Caribou shift to lower elevations and more densely canopied forests. Western hemlock habitats with high snag densities are used extensively during this season. Snags are related to the availability of windthrown trees and deadfalls that increase lichen availability. Their food habitats are in a transition from vascular plants to the winter diet of arboreal lichens.

PRIMARY ISSUES

- Late Successional Timber Stands
- Human Disturbance
- Fire Management
- Herd Augmentation
- Direct Mortality

ISSUE: Late successional timber stands

Woodland caribou are considered closely associated, if not obligates of late successioinal timber (old-growth). Most notably are the Western cedar/hemlock and subalpine fir/Englemann spruce stands above 4,000 feet elevation. Timber harvest alters caribou habitat and creates additional human access. Logging can potentially affect caribou habitat by eliminating escape (security) over, migration corridors, and lichen production. Although food availability is probably not now limiting this caribou population, long-term population survival will partially depend on adequate lichen production and availability. Additionally, timber harvest may alter historic predator and prey densities, thereby exacerbating the predation issue by providing increases in other big game populations which provide for increases predator numbers, most notably cougar.

SUGGESTED CORRELATES:

-Acres of western cedar/hemlock stands
-Acres of subalpine fir/Englemann spruce stands
-Acres of Ecotone between cedar/hemlock and spruce/fir
-Acres of potential old-growth stands

ISSUE: Human Disturbance

Mountain caribou are generally considered fairly tolerant to human presence. However winter recreation has been identified as a major disturbance factor, particularly , snowmobile activity when caribou are utilizing the alpine and subalpine during late winter (USFWS 1994, USFS 1995). Research and management work from the Revelstoke, B.C. area has shown that caribou are actively displaced from areas of cross-country snowmobile activities. (Simpson1986)

Suggested Correlates:

-Groomed snowmobile trails
-Open alpine areas accessible to snowmobiles

Selected References:

ISSUE: Fire Management:

Fire is another factor in maintaining late successional timber stands, and in the past has destroyed caribou cover and winter food. Examples are the Salmo Basin in 1919, Sundance in 1967, and the Trapper Peak 1967). (U.S. Fish and Wildlife Service 1994). The cumulative effects of logging, fire and other phenomena have eliminated a great deal of the herd's historic habitat. Present policy is the "rapid and aggressive suppression of all fires" within the caribou recovery zone.

However, some level of fire management may be desired to maintain age class distribution suitable for long-term habitat management. Also, introduction of managed fire may be beneficial in reducing the risk of larger uncontrolled fires that could modify otherwise suitable habitat.

Suggested Correlates:

- -Access management
- -Acres of non-target stand conditions.

ISSUES: Direct Mortality

With a small population that exists with the Selkirk caribou, the loss of a single individual is of concern. Illegal shooting by poachers and hunters who mistakenly identify caribou for other game animals has been an important source of mortality for Selkirk caribou (USFWS 1985). Preventing illegal mortality has been a high priority in the Selkirks. Motor vehicle use is restricted on many forest roads in the U.S., reducing caribou vulnerability to human caused mortality (USFWS 1994)

Caribou-vehicle collisions are of a concern along B.C. Highway 3. Caribou cross and loiter along the road at all times of the year. warning signs and electronic billboards are helping to reduce vehicle speeds and increase driver awareness (USFWS 1994)